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ABSTRACT

This document is the student laboratory manual that was designed to accompany some of the experimental activities found in the teacher's guide to this general science course for ninth graders. It contains laboratory worksheets for lessons on such topics as: (1) soil; (2) hazardous waste; (3) wildlife refuges; (4) the water cycle; (5) water treatment; (6) air pollution; (7) acid rain; (8) infectious and noninfectious diseases; (9) human life expectancy; (10) cancer; (11) the identification of new diseases; (12) the microscope; and (13) bacteria. Also included is a list of science safety rules. (TW)

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GENERAL SCIENCE

Experimental

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Theme III

Theme IV

NINTH GRADE

Student Laboratory Manual

NEW YORK CITY BOARD OF EDUCATION
Office of Curriculum Development and Support
Division of Curriculum and Instruction

SE 048 360

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NOTE

These worksheets are intended for use in conjunction with the lessons included in Ninth Grade General Science, Themes III and IV. To facilitate the use of these materials, each worksheet has been coded to correspond to a specific theme and lesson. In addition to the worksheets, other selected materials are included. Copies of all these materials also appear in the teacher's guide.

SCIENCE SAFETY RULES

a. Report all accidents to your teacher at once.
b. If any substance spills on you or gets into your eyes, wash your eyes at the eye wash station with water and notify your teacher at once.
c. Do not perform unauthorized experiments. Follow directions.
d. If any glassware breaks, inform your teacher at once. Do not touch the broken glass nor use chipped test tubes or beakers.
e. Waft odors toward your nose and then sniff cautiously to avoid damage to your nasal passages and lungs.
f. Never handle the apparatus or chemicals in the laboratory until you have been instructed how to handle them safely.
g. Don't wear loose-fitting clothing that can accidentally come into contact with science apparatus, reagents, or flames.
h. Do not carry dangerous chemicals from one place to another.
i. Do not taste chemicals or other unknown materials.
j. Read the specific safety instructions for each laboratory activity that you will perform.
k. Never pour reagents back into bottles.
l. Steel wool should be handled carefully to avoid getting any fragments into the skin.
m. Do not touch any hot materials with your hands.
n. Always point the mouth of a test tube away from yourself and from others when heating it.
o. Do not look directly at the sun; be especially careful when working with lenses and mirrors in sunlight.
p. Do not use thermometers as stirring rods.
q. Immediately report spilled mercury to your teacher.
r. Wear approved eye protectors such as safety goggles whenever working with corrosive chemicals, heating liquids, or processing solids that may shatter.

LABORATORY WORKSHEET 3.1

NAME_____ CLASS_____ DATE_____

PROBLEM: What can we discover by examining soil with a magnifier?

MATERIALS: Hand lens or microscope, 10 ml of soil in a half of a petri dish.

INTRODUCTION: As we have already learned, soil is the result of the weathering of rocks. But as you will discover today, soil contains much more than lifeless rock particles.

PROCEDURE:

1. Spread out your soil sample into a thin layer in a petri dish.

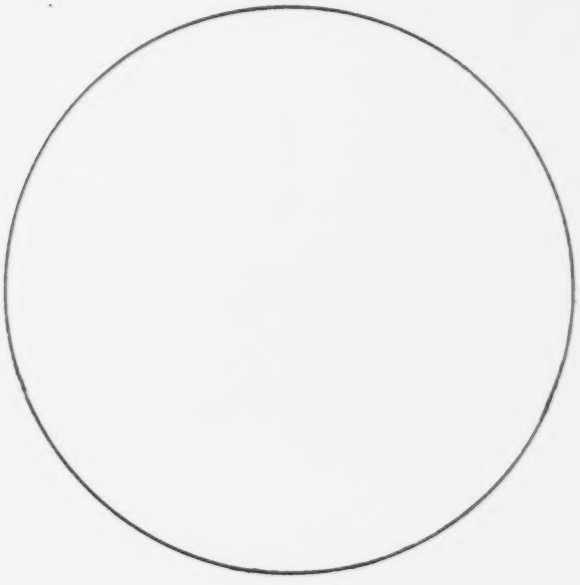
2. Examine your sample with either the hand lens or microscope provided. Search for anything that looks like wood. In the space below, describe your magnified soil sample in words and make a sketch in the circle.

_____

_____

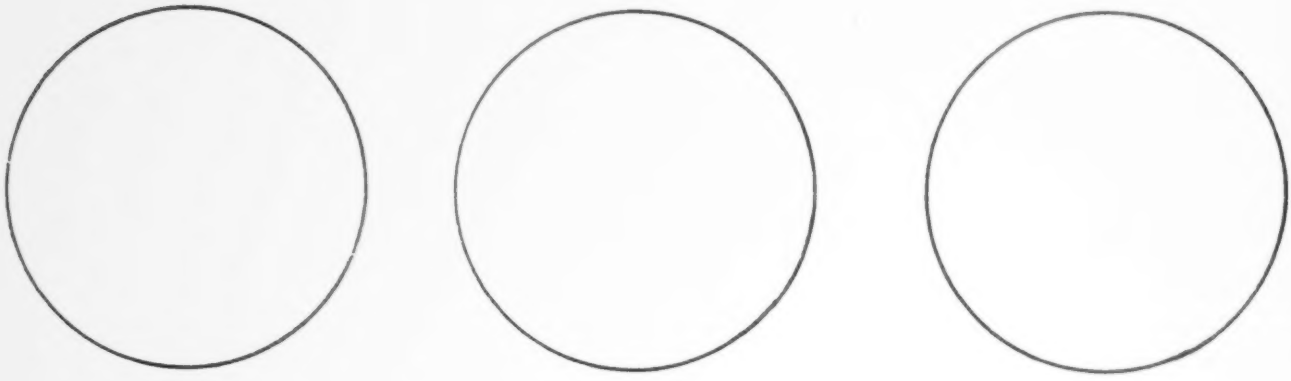
_____

_____



LABORATORY WORKSHEET 3.1 (continued)

3. Examine your soil sample for parts of trees or plants. Can you find any roots? Any stems? Any leaf parts? If so, draw what you find and label your drawings.



4. Locate grains of sand or rock particles. Draw them.

5. Are there any insects in your soil sample? If so, what did you discover?

_____

_____

SUMMARY/HOMEWORK

1. Why is the decay of the remains of plants and animals useful in the building of soil?

2. Why may soil in one place be quite different from soil only one kilometer away?

LABORATORY WORKSHEET 3.2

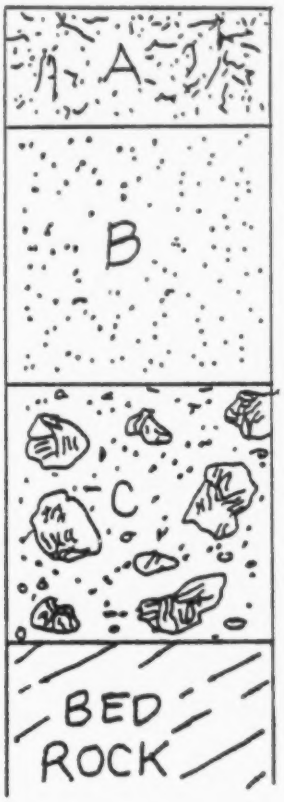
NAME_____ CLASS_____ DATE_____

PROBLEM: What can we learn from a soil profile?

INTRODUCTION: In order to see what is in the soil, we have to examine it from the side. Such a view is called a soil profile. The layers in a soil profile are called horizons. The uppermost horizon is named Horizon A; the next Horizon B, and so on. By examining a soil profile, a soil scientist can tell many things, such as if the soil is suitable for farmland, recreational areas, or homes.

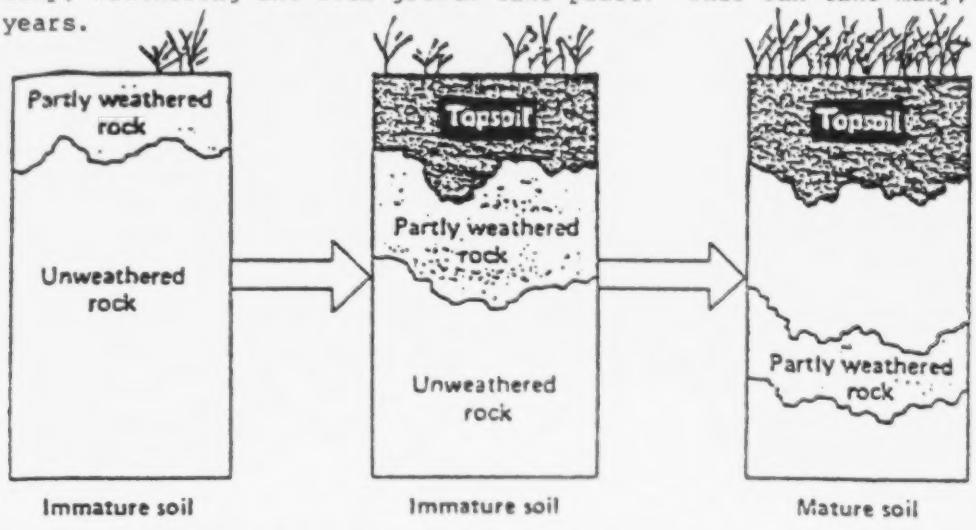
PROCEDURE

1. This is what a soil profile might look like:



LABORATORY WORKSHEET 3.2 (continued)

2. In its original state, there is unweathered rock at the surface. Gradually, weathering and soil growth take place. This can take many, many years.



3. Observe the soil profile your teacher has displayed.

   a. How many horizons can you see?

   b. Draw it below to the best of your ability. Label each horizon.

LABORATORY WORKSHEET 3.2 (continued)

c. Was this soil profile taken from immature or from mature soil? How do you know?

_____

_____

d. Name three weathering processes that are responsible for Horizon B.

_____

_____

_____

e. How was Horizon A formed?

_____

_____

SUMMARY/HOMEWORK

1. Which soil profile would be best suitable for building a 25-story apartment house? Why?

2. If you were a soil scientist, which soil horizon would you suggest a farmer look for when purchasing a farm? Why?

LABORATORY WORKSHEET 3.3

NAME_____ CLASS_____ DATE_____

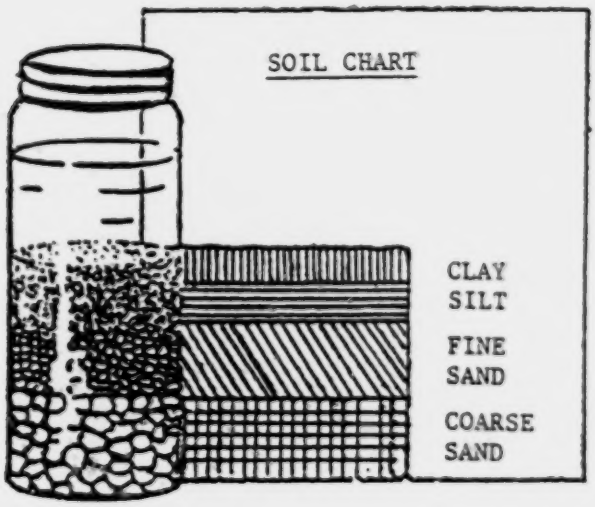
PROBLEM: How much water can different types of soil retain?

MATERIALS: 5 x 8 index card, BB shot, graduated cylinder, marbles, metric ruler, soil samples, tall jar with a tight-fitting cover, transparent tape, two beakers of equal size: one two-thirds filled with marbles, the other two-thirds filled with BBs or small steel bearings.

INTRODUCTION: Most soils found in nature contain a mixture of sand, silt, and clay particles, plus humus. The proportion of each will vary from soil sample to soil sample. You will learn today how particle size determines the ability of the soil to hold water.

PROCEDURE

1. Fill a tall jar about two-thirds full of water.
2. Add enough soil to <u>almost</u> completely fill the jar.
3. Cover the jar tightly and shake it vigorously for about three minutes.
4. Place the jar on a horizontal surface and leave it undisturbed for several minutes until the particles settle and the water on top is clear.
5. Tape an blank index card to the back of the jar.



LABORATORY WORKSHEET 3.3 (continued)

6. Based on your observations thus far, prepare a diagram similar to the preceding one. The heaviest and largest particles will be on the bottom. Try to make your drawing as accurate as possible.

7. If it is possible, leave the jar undisturbed until the next science period. This will allow sufficient time for even the finest of particles to settle out.

8. Using your metric ruler, complete the following table:

   a. The total depth of soil in the jar is _____ mm.
   b. The thickness of the sand layer is _____ mm.
   c. The thickness of the silt layer is _____ mm.
   d. The thickness of the clay layer is _____ mm.
   e. In this soil sample, _____% is clay, _____% is silt and _____% is sand (by volume).

9. Fill a graduated cylinder with water and record the water level. _____ml

10. Pour water from the graduated cylinder into your beaker that is two-thirds full of dry marbles. Then pour the water back into the graduated cylinder and record the water level again. _____ml

11. Subtract the levels recorded in steps 9 and 10 to find the amount of water that was retained by the marbles. _____ml

12. Repeat the procedures of steps 9 to 11 using your other beaker that is two-thirds full of dry BBs. How much water was retained by the BBs? _____ml

13. a. Which held more water, BBs or marbles? _____

    b. Explain why either the marbles or the BBs held more water.

_____

_____

SUMMARY/HOMEWORK

1. How does size of soil particle affect the amount of water that the soil can hold?

2. Why does sandy soil hold less moisture than clay soil?

LABORATORY WORKSHEET 3.4

NAME_____ CLASS_____ DATE_____

PROBLEM: How can the amount of organic matter in a soil sample be estimated?

MATERIALS: For each group of student experimeters: four 250 ml beakers, two soil samples from the same site (one taken from the top 5-10 cm depth, the other from 40-50 cm depth), wax marking pencil, H_2O_2 solution (6%), scoop, ruler.

INTRODUCTION: Today you will determine the amount of organic matter in a soil sample. This test is often performed by a soil technician for a soil scientist. Soil rich in organic matter is necessary if crops are to be grown. Usually, the organic matter in soil is dark in color due to its high carbon content. Hydrogen peroxide (H_2O_2) oxidizes carbon compounds. Often, when a compound is oxidized, its color changes. This is why H_2O_2 is used to bleach hair. We will see how H_2O_2 affects the color of our soil samples.

CAUTION: You must wear safety goggles at all times during this laboratory period.

PROCEDURE

1. Label your beakers 1, 2, 3, and 4.
2. In beakers 1 and 2, place 4 cm of soil taken from the upper layers.
3. Place 4 cm of soil taken from the deeper layers into beakers 3 and 4.
4. Add water to beakers 1 and 3 to just cover the soil samples.
5. Add 6% H_2O_2 to cover the soil in beakers 2 and 4.
6. Observe all beakers carefully. In which beaker do you observe the most bubbling?

   _____

   In which do you observe the least? _____
7. Wait until all bubbling has stopped. If the liquid in beakers 1 and 2 is not clear, add some water and wait until clearing takes place.

LABORATORY WORKSHEET 3.4 (continued)

SUMMARY/HOMEWORK

1. Compare the colors of the soil samples.

   A. How does the color of the soil in beaker 1 compare with the color in beaker 2?

   _____

   B. Compare the soil color in beakers 3 and 4.

   _____

   C. How does the soil color of beaker 2 compare to that in beaker 4?

   _____

   D. Explain your observations. _____

   _____

2. Why are beakers 1 and 3 important for this experiment?

   _____

3. Why do your soil samples have different amounts of organic matter?

   _____

4. Why might a soil scientist want to have this test performed?

   _____

LABORATORY WORKSHEET 3.5

NAME_____ CLASS_____ DATE_____

PROBLEM: How is soil moved?

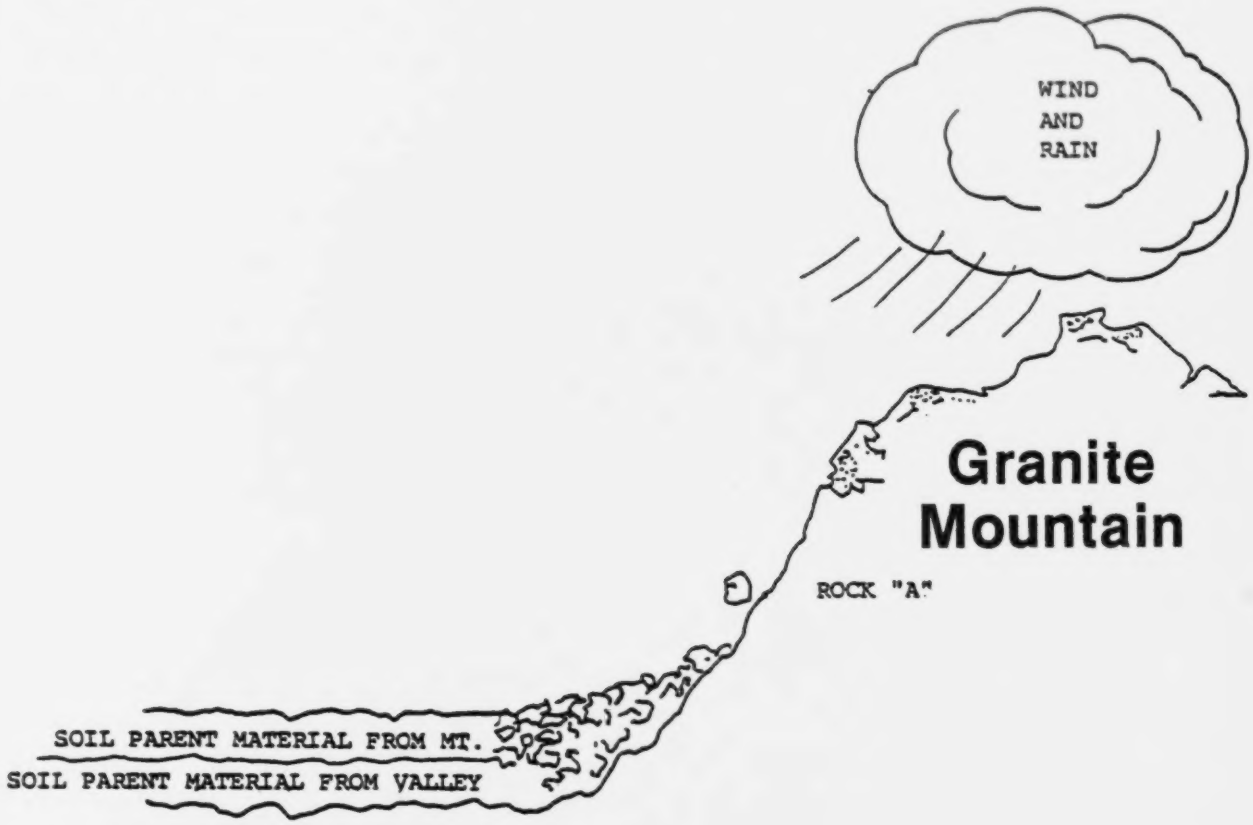
MATERIALS: Soil samples; samples of granite, quartz, feldspar, mica, and clay; pictures of gullies, dust-bowls, blow-outs, etc.

INTRODUCTION: Many things influence soil movement, especially water and wind. Before we can discuss the factors that make the soil in New York State different from that in Alaska, we must talk about parent material. The parent material consists of broken rocks.

PROCEDURE

I.

1. Examine the illustration below. Study it and then answer the questions that follow.



LABORATORY WORKSHEET 3.5 (continued)

2. Three ways that small rocks and rocky material can get from the top of the mountain to the valley below are:

   A. _____

   B. _____

   C. _____

3. What force is moving rock A down the mountain?

   _____

4. Why is the term "soil parent material" an appropriate term?

   _____

5. What must be added to soil parent material to change it into "soil"?

   _____

6. Compare the composition of the soil at point 1 with the composition of soil at point 2.

   _____

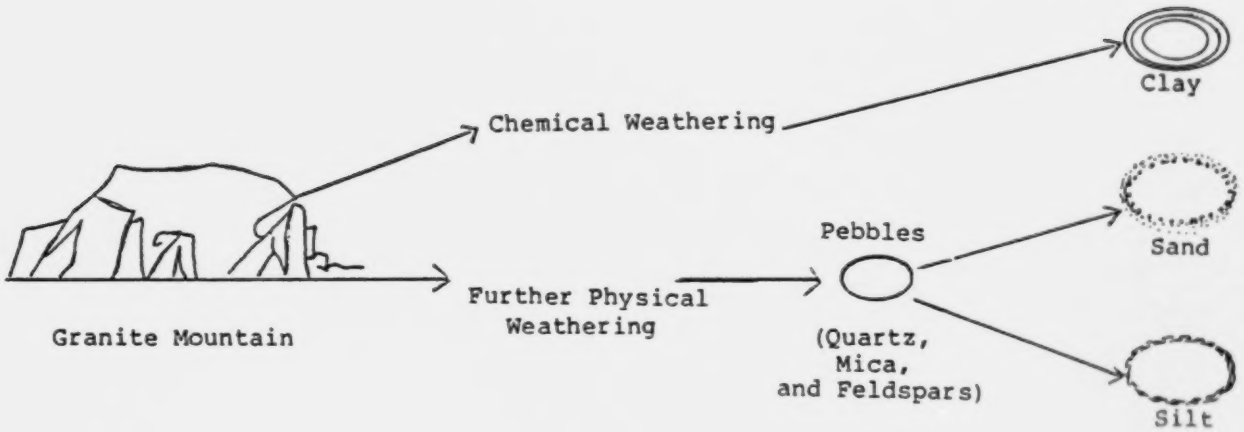
7. What could be done to keep the soil at point 1 from being moved to point 2?

   _____

II.

1. Examine the following diagram that illustrates how granite is weathered. Your teacher will distribute samples of granite, quartz, feldspar, mica, and finally clay. Examine them carefully, and referring to the chart, answer the questions that follow.

LABORATORY WORKSHEET 3.5 (continued)



2. What chemicals can cause weathering?

_____

3. Describe the appearance of the mica you saw in the granite rock.

_____

4. What are two ways that mica differs from quartz?

_____

_____

SUMMARY/HOMEWORK

1. Why will the soil parent material in a valley be different from the soil parent material in the surrounding mountains?

2. Why is the planting of grass a good way to prevent the loss of topsoil?

3. Cite evidences that prove that soil is being made by natural forces at this very moment.

LABORATORY WORKSHEET 3.6

NAME _____ CLASS _____ DATE _____

PROBLEM: How can our topsoil be lost?

MATERIALS: Two run-off trays, one with sod, the other with bare soil, two one-liter graduated cylinders, two watering cans.

INTRODUCTION: Each year more and more soil in the central United States becomes unfit for farming. This is because a good deal of the all-important topsoil has disappeared leaving a hard surface made of packed soil and small pebbles. The loss was due to erosion and caused by wind, water, and ice.

During the early days of this country, the leaves of trees in the forests and the grasses of the prairies softened the force of the rain drops. This meant that the rain could fall for many hours without damaging the soil. The humus in the topsoil that was formed by decaying plant parts soaked up most of the water from even the heaviest rains. Today, however, the trees and grasses have been removed to make way for farmland. Now, the bare ground, with few plants, takes the full force of the rain.

PROCEDURE

Explain your procedure step by step in the space below.

Part I

Using the equipment provided, design an experiment to determine which tray of topsoil would be more easily washed away by rain water.

LABORATORY WORKSHEET 3.6 (continued)

From the results you obtained in your experiment complete the following:

A. Amount of water collected from bare soil tray = _____ml

B. Amount of water collected from the sod tray =_____ml

C. Which graduated cylinder had muddier water? _____

D. What conclusions can you draw from the data? _____

_____

Part II

Read the following passage. Do your data and conclusions agree with this reading passage?

> When rain falls on bare earth, very little soaks into the soil. Instead, it runs off carrying large amounts of topsoil with it. As more and more soil is eroded by the rains, less soil remains. Also, the remaining soil loses its ability to absorb water. The effects of erosion by water get worse and worse with each rainstorm. When soil in this condition dries out, it is very easily blown away.
>
> Water and wind erosion result in the loss of soil and the loss of the ability to grow crops, as well as the loss of water. During periods of heavy rain, rivers soon become flooded because the water is flowing over the soil rather than being absorbed by it. Floods can now occur quickly and easily. When little or no rain is absorbed by an eroded area, a drought soon occurs.

SUMMARY/HOMEWORK

1. In what ways have people had a negative effect upon our topsoil?
2. How do plant roots help hold soil in place?
3. How else do plants protect the soil?
4. "Soil erosion, if untreated, gets worse and worse each year." Explain this statement.
5. Prepare a report on methods used to prevent soil erosion due to the action of water and wind.

LABORATORY WORKSHEET 3.7

NAME_____ CLASS_____ DATE_____

PROBLEM: What goes on inside a "mini-landfill"?

MATERIALS: One dozen or more tall clear plastic or glass drinking containers, soil, aluminum foil, plastic wrap, rubber bands, stirring rods, garbage (meat, bread, vegetables, newspapers, scrap metal, pieces of plastic), four different vegetable dyes (i.e., red, green, yellow, pink).

INTRODUCTION: Many communities get rid of their garbage by burying it under a covering of soil. This is called a landfill. If a city disposes of garbage by this method, an acre of ground (4047 square meters) about 2 meters deep is necessary for every 10,000 people each year.

Today you are going to set up two simple experiments related to landfills. The first will allow you to see what happens under the surface of a landfill. The second experiment will show you what happens to biodegradable materials in the soil.

PROCEDURE

1. Fill a tall glass or plastic drinking container with soil to within 3 cm of the top.

2. In each, bury pieces of garbage (meat, vegetable matter, bread, newspaper, plastic, metal) at varying depths. (If more than one group of students is doing this experiment, each group should bury its garbage at different depths.) Place each piece of garbage next to the outer edge of the drinking container. In this way, you can make visual observations of each sample of garbage.

3. Moisten the soil, but don't get the soil waterlogged.

4. Cover each container with a piece of aluminum foil held snugly in place with a rubber band.

5. Wait three days, then examine your garbage landfill daily and keep a record, on the chart provided, of how rapidly each garbage item decomposes. Express the amount decomposed as a fraction or as a percentage of the original sample.

LABORATORY WORKSHEET 3.7 (continued)

Percent Decomposed

garbage item	3 days	5 days	7 days	9 days

SUMMARY/HOMEWORK

1. Did you see any spaces where garbage had been? _____
   If so, how can you account for the empty space?

   _____

2. What is in these spaces?_____

3. In Los Angeles, a landfill that was 90-feet deep sank over 5 feet in three years. What can this landfill be used for?

   _____

4. You need 4047 square meters of ground 210 cm deep for every 10,000 people each year if you dispose of garbage by the use of landfills. The population of your community is _____ people. How much land will you need for your community in the next five years? (Assume that your landfill can be 42 meters tall.)

LABORATORY WORKSHEET 3.8

NAME_____ CLASS_____ DATE_____

PROBLEM: What problems were caused by the landfill at Love Canal?

INTRODUCTION: On May 21, 1980, President Carter declared a state of emergency at the Love Canal in Niagara Falls, N.Y. He authorized the government to pay for the relocation of 710 families. Let's find out how a landfill caused this emergency.

PROCEDURE

1. Read the following excerpts from Time Magazine and US News & World Reports, issues of 6/2/80.

Living with Uncertainty: Saga of Love Canal Families

Background: Starting in the 1930s the Hooker Chemicals and Plastics Corp. had disposed of its toxic chemical wastes in metal drums in a deep, open trench--the remains of an aborted 19th century attempt to dig a canal between the Niagara River and Lake Ontario. In 1953, the company turned the site over to the Niagara Falls Board of Education, which filled the ditch and built a school on the site. The school board sold part of the property to developers who built private homes there. In the years that followed, heavy rains fell in the Niagara Falls area, the drums holding the chemical wastes began to rot, and in 1976 the chemicals made their way to the surface.

AFTER THREE YEARS OF CONSTANT FEAR, AN ENTIRE NEIGHBORHOOD IS FLEEING TO ESCAPE THE HAZARDS OF BURIED CHEMICALS.

NIAGARA FALLS, N.Y.

An emergency declared by President Carter at the site of an abandoned toxic-chemical dump here signals only stopgap relief from the growing nationwide risks of hazardous wastes.

Once a pleasant neighborhood of tree-lined streets, the Love Canal section of this industrial city is turning into a boarded-up ghost town with the exodus of 710 more families that began in late May, three years after dangerous conditions came to light.

People told their bitter stories as they prepared for an evacuation to be financed partly with federal funds released by the emergency declaration. The action was spurred by studies suggesting that residents were subject to higher rates of cancer, birth defects, miscarriages, and chromosome damage.

"I lost a baby after carrying her for nine months," says Marge Bates. "She weighed only three pounds and was still-born. My doctor couldn't explain why, after nine months, she weighed only three pounds. It had to be the chemicals."

Buried underground in leaky drums are 20,000 tons of toxic substances, including lethal dioxin....

An 8-foot-high fence surrounds the site, sealing off an empty elementary school built atop the filled-in canal and 237 homes abandoned in 1978 when the state of New York relocated families living nearest the dangerous wastes. Outside the fenced-in area are other shuttered houses deserted by families with pregnant mothers or small children who were relocated from a wider area.

"The boys used to play on a baseball diamond beside the school, and this bluish-black stuff would ooze up through the ground," reports Phyllis Whitenight, a mother of five.

She had surgery for breast cancer in 1975 and says seven cases of cancer have been discovered among her neighbors in the 15 houses on 96th Street, a few blocks from the canal.

Pesticides and other poisons dumped into the canal have polluted ground water that is seeping into basements, creating hazardous vapors. Residents were cautioned to avoid their basements after air tests in homes found the presence of 80 toxic chemicals.

"We couldn't figure out why my wife developed epilepsy when no one else in her family had ever had it," recalls Harry Tolli, a shipping clerk. "I doubted that it was the chemicals at first. But we found out they were in the water backing up in the basement through the storm sewers."

No gardens. Health officials, worried about possible contamination, also warned residents against eating home-grown vegetables. "We had a vegetable garden, but I had to let it rot," says Walter Mikula. "They said it was all right to live here, but don't eat the vegetables."

U.S. News and World Report, 2 June 1980.

25

The Neighborhood of Fear

Carter orders a further evacuation from polluted Love Canal

Robert Kott loved the small, neat home overlooking Black Creek in the southeastern corner of Niagara Falls, N.Y., a grimy industrial town near the Canadian border. In the 14 years since he acquired it the muscular chemical worker has spent thousands of hours painting, insulating, and otherwise caring for his precious property. But last week Kott called it quits, shuttering up the house and fleeing with his wife Joann and their five children, ages seven to 15. Said he: "I don't mind telling you we've been scared for a long time, scared for our lives."

So, too, were many of the Kotts' neighbors. Over 700 families in all, they live around Love Canal, the notorious, stinking chemical sewer that has become a symbol of the country's growing toxic waste problem. For the past two years, one report after another has told harrowing tales of noxious odors leaking into homes, of sinister-colored sludge seeping into basements, of children playing in potholes of pollutants and, worst of all, of abnormally high rates of miscarriages and birth defects, of nerve, respiratory, liver and kidney disorders, and of assorted cancers among the people of Love Canal.

When the nature of this toxic time bomb finally became fully understood in 1978, New York State relocated 239 families whose homes were closest to the dump (cost: $37 million).

Last week President Carter finally responded to their pleas. Following the disclosure of still another study reinforcing the residents' worst fears--that the chemical wastes may be causing genetic damage--Carter declared a state of emergency in the area, and empowered New York State and the U.S. Environmental Protection Agency to undertake the temporary relocation of 710 families. Among them: the Kotts, three of whose children show a frightening tendency toward convulsions.

Time, 2 June 1982.

LABORATORY WORKSHEET 3.8 (continued)

SUMMARY/HOMEWORK

1. What caused the Love Canal emergency?

2. Why was an elementary school abandoned?

3. How effective is the high fence around Love Canal for controlling the problem?

4. Why were the residents told to avoid going into their basements?

5. Why were residents warned against growing lettuce and tomatoes in their gardens?

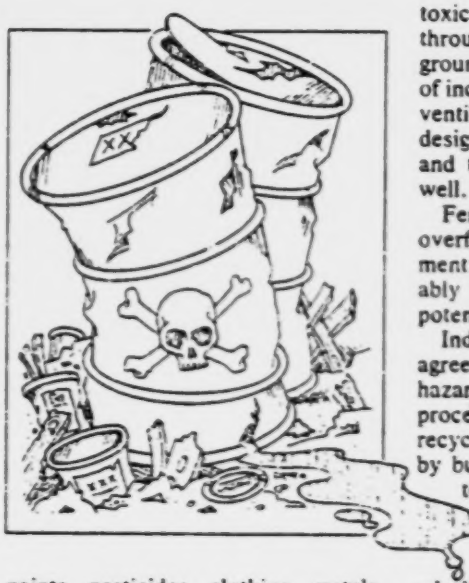
6. Name four health problems associated with toxic wastes.

7. Who should pay for the new homes the Love Canal residents will need? State reasons for your answer.

Toxic wastes sites

Love Canal, N.Y., Times Beach, Mo., Valley of the Drums, Ky.—their tragedies have made them famous. Now they're synonyms for toxic-waste contamination. Unfortunately, the public-health and environmental problems posed by hazardous wastes are not restricted to just a few sites, or even a few regions of the country.

According to EPA estimates—which some environmentalists think are too low—there are at least 14,000 potentially hazardous toxic chemical dump sites across the country! More than 400 of the most dangerous sites *have* been targeted for priority cleanup under the federal government's $1.6 billion Superfund program. But recent controversy within the EPA has raised questions about how ably such cleanups are being carried out.



What are hazardous wastes and where do they come from?

Toxic chemicals, such as dioxin, PCBs, asbestos, and lead are among the most widely publicized. But actually *any* discarded material—liquid, solid, sludge, or gas—that may pose a serious risk to public health or the environment can be considered a hazardous waste. Among the more serious potential hazards are acute and chronic health problems to human beings due to polluted air and groundwater.

Most of the waste is produced by the same industries that provide us with, among other things, plastics, paints, pesticides, clothing, metals, fertilizer, and medicines.

How do the hazards occur?

"Midnight" dumping of hazardous wastes into sewers, on vacant lots, or along roadsides is one way. The same is true of abandoned or unmonitored dump sites, full of rusting barrels whose chemical contents ooze into the ground or surrounding waters.

Hazardous-waste landfills—areas set aside as special dump sites—can also cause problems especially when they are not sealed and lined properly with clay or plastic. In such cases water may penetrate them, mix with toxic chemicals, and eventually seep through, contaminating the underground water supplies. The dumping of industry's hazardous waste in conventional sanitary landfills—the kind designed for nonhazardous garbage and trash—is a serious problem as well.

Fertilizer and pesticide runoff and overflows of waste-storage and treatment ponds—of which there are probably 170,000 in the U.S.—are other potential sources of trouble.

Industry and environmental experts agree that it is possible to reduce the hazards by modifying the industrial processes that produce the waste: by recycling as much as 20 percent of it; by burning it up in special incinerators; by neutralizing it with other chemicals; or by reprocessing and distilling it.

Whatever the preferred method, though, the fact remains that with 80 billion pounds of hazardous waste being produced in the U.S. each year, more and safer hazardous-waste management sites are needed. Without them, hazardous wastes will continue to be dumped in inadequate facilities or in the open.

What can you do?

If you want to find out if a dump site is on the EPA's potentially hazardous list, contact the EPA's nearest regional office. For those addresses and telephone numbers and for more information on Superfund cleanup programs, call 800-424-9346. To report spills or other emergencies where you suspect contamination, call EPA's Emergency Response Center at 800-424-8802. Contact local public-health authorities and elected officials as well.

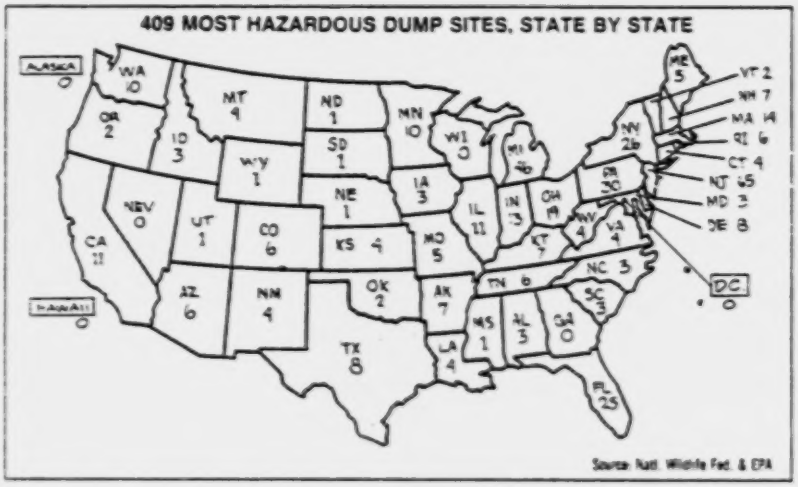
And if a hazardous-waste site is proposed for your town, be sure to find out what kind of wastes will be accepted, how they will be transported, how close the site will be to population centers, schools, and hospitals, and who will be responsible for the site after it is closed.

In the meantime, here are some other facts you should know.

THE NATION'S 20 WORST DUMPS

Location	Name
Fridley, Minn.	FMC
New Castle County, Del.	Tybouts Corner
Bruin Boro, Pa.	Bruin Lagoon
Woburn, Mass.	Industri-Plex
Pitman, N.J.	Lipari Landfill
Wellsville, N.Y.	Sinclair Refinery
Pleasantville, N.J.	Price Landfill
Oswego, N.Y.	Pollution Abatement Svc.
Charles City, Iowa	Labounty Site
Mantua, N.J.	Helen Kramer Landfill
New Castle, Del.	Army Creek
Old Bridge Township, N.J.	CPS/Madison Industries
Ashland, Mass.	Nyanza Chemical
Gloucester Township, N.J.	Gems Landfill
Coventry, R.I.	Picillo Coventry
Swartz Creek, Mich.	Berlin & Farro
Cherokee County, Kan.	Tar Creek
Holbrook, Mass.	Baird & McGuire
Freehold, N.J.	Lone Pine Landfill
Somersworth, N.H.	Somersworth Landfill

where they are and what to do



SOURCES OF INFORMATION ON HAZARDOUS WASTE

Citizens Clearinghouse on Hazardous Waste
P.O. Box 7097
Arlington, Va. 22207
(703) 532-6816

Citizens for a Better Environment
59 E. Van Buren, Suite 1600
Chicago, Ill. 60605
(312) 939-1530

Environmental Action Foundation
724 Dupont Circle Building
Washington, D.C. 20036
(202) 296-7570

Environmental Defense Fund
1525 18th Street. N.W.
Washington, D.C. 20036
(202) 833-1484

League of Women Voters
1730 M St., N.W.
Washington, D.C. 20036
(202) 429-1965

National Wildlife Federation
1412 16th St., N.W.
Washington, D.C. 20036
(202) 797-6800

Sierra Club
530 Bush St.
San Francisco, Calif. 94108
(415) 981-8634

Solid Wastes Management Assoc.
1120 Connecticut Ave., N.W.
Washington, D.C. 20036
(202) 659-4613

HOW TO DETECT A "HIDDEN" DUMP SITE

Be suspicious about:

- places where nothing grows or that animals avoid
- withered or yellow patches of vegetation, especially near a landfill site
- offensive odor, taste, or color in drinking water*
- noxious fumes or an unidentifiable odor in the air
- headaches, dizziness, eye irritation, and related symptoms that occur in one location, such as where you work, but disappear when you leave
- odd behavior or physical deformities in newborn animals
- discarded barrels and drums
- death or disappearance of marine life
- neighborhood patterns of serious health problems, such as liver disease and cancer

If you think someone is breaking the law, find out what state or local agency, such as the County Health Department or State Hazardous Waste Management Office, is responsible for enforcing it, and notify the agency of the suspected violations. (Environmental Action Foundation can assist you. See resource list.)

* However, many organic water pollutants can neither be seen nor tasted and, under present federal law, do not have to be tested for in public drinking water.

LABORATORY WORKSHEET 3.9

NAME_____ CLASS_____ DATE_____

PROBLEM: Where do hazardous wastes come from?

INTRODUCTION: Toxic chemicals have been dumped into sewers, streams, lakes, rivers, oceans, forests, fields, trenches, and even along the sides of roads. This is a national problem and happens in every state.

PROCEDURE

Examine the chart.

1. Which industry produced the least toxic waste?

   _____

2. Name the three main sources of chemical hazardous wastes in 1977.

   _____

3. How many million metric tons of waste came from the three main sources listed above?

   _____

Where Hazardous Wastes Come From

Industry	Million Metric Tons in 1977
Batteries	0.164
Inorganic Chemicals	3.900
Organic Chemicals, Pesticides and Explosives	11.666
Electroplating	4.053
Paint and Allied Products	0.110
Petroleum Refining	1.841
Pharmaceuticals	0.074
Primary Metals Smelting and Refining	8.973
Textiles Dyeing and Finishing	1.870
Leather Tanning	0.143
Special Machinery	0.153
Electronic Components	0.078
Rubber and Plastics	0.944
Waste oil Re-refining	0.074
Total	34.043

Source: Environmental Protection Agency

"Where Hazardous Wastes Come From," in *Editorial Research Reports*, vol. 2, 1978, p. 743.

The entire chemical industry, including manufacturers of substances such as plastics, drugs, and paints, sold some $113 billion worth of products in 1977, an 11 percent increase over the previous year. By comparison, the industry sold only $13.7 billion worth of chemicals in 1947. Environmentalists, health officials, and others contend that many new chemicals come into widespread use well before toxicologists are able to determine their effects on health and the environment.

Love Canal may not be the worst toxic waste problem in New York State.

Agent Orange

Adapted from an article written
by Robert Rickles and Harold Holzer

In Vietnam, the U.S. dropped 350 pounds of Agent Orange's deadliest ingredient. Today, there's a full ton buried in upstate New York.

For eight years of the Vietnam War, American soldiers used a weapon called Agent Orange. A powerfully corrosive chemical defoliant, Agent Orange destroyed thousands of acres of Southeast Asian vegetation and agriculture--permanently.

Since then, many of the servicemen who handled Agent Orange have been claiming, in and out of court, that their own contact with the defoliant has caused them serious health problems.

A scientific task force wants to discover, once and for all, what the most dangerous ingredient in Agent Orange--the chemical dioxin--does to the human body. According to David Weir, coauthor of Circle of Poison, dioxin is "one of the most fiendishly toxic substances known."

But while attention is focused on Vietnam for these elusive answers, the Agent Orange catastrophe threatens a small area of northern New York State near Niagara Falls. There, at Hyde Park, on a sixteen-acre chemical dump site, an American corporation has buried a full ton of deadly dioxin--a quantity six times greater than the amount dropped on Vietnam.

Worse yet, recent evidence indicates that what was buried about thirty years ago may now be resurfacing. It poses great danger in the form of dioxin to five million people by seeping into the nearby Niagara Gorge, which feeds fish-laden Lake Ontario.

LABORATORY WORKSHEET 3.9 (continued)

Experts say that the potential to poison is so great it could make Love Canal look like a poison-ivy epidemic by comparison. Not surprisingly, the company behind the Hyde Park dump is the very same firm that filled Love Canal with toxins--Hooker Chemical Corporation.

In fact, the Hyde Park landfill is the site where Hooker dumped chemicals after its Love Canal site was filled. In all, Hooker dumped some 80,000 tons of dangerous chemicals into Hyde Park between 1953 and 1974. In addition to 2000 pounds of dioxin, such carcinogens as trichloroethylene, monocholrobenzene, and hexachloro-butadiene were also buried there. In terms of both area and volume of material, Hyde Park now has one of the largest concentrations of dangerous chemicals dumped in any single site on the earth.

The Federal Environmental Protection Agency (EPA) and the State of New York have quietly negotiated an agreement with Hooker to clean up Hyde Park. Independent studies suggest that it will cost from $150 million to $250 million to clean up the dump.

Strangely, the Hyde Park time bomb received very little attention from press or public until 1978, and then quite by accident. Prior to 1978, cursory inspections by the Niagara County Health Department and the New York State Department of Environmental Conservation suggested there was very little wrong that could not easily be cured. They called for such controls as modest drainage systems, but little else.

Adapted from Rickles, Robert, and Harold Holzer "Agent Orange," *Rolling Stone*, 4 March 1982, p. 11.

Agent Orange: What It Is and Does

By Dianne Ripley

From 1962 to 1970, a defoliant was sprayed over 5 million acres of Vietnam in a campaign called Operation Ranchhand. Its purpose was to eliminate vegetation used as camouflage by the Viet Cong and to destroy the enemy's crops and food supplies. The name given to this herbicide was Agent Orange. Chemists know it as 2,4,5-trichlorophenol, or 2,4,5-T.

The danger of 2,4,5-T lies in a by-product of its manufacture--tetrachlorodibenzoparadioxin, or dioxin. Dioxin is an insidious contaminant said to be one of the most toxic substances known to man; its toxicity is so high that it is measured in parts per trillion rather than in parts per million. Some experts say that if three ounces of dioxin were spilled into the New York City water supply, it would be fatal to the entire city's population.

Dow Chemical Company is the major manufacturer of 2,4,5-T in the United States. Though Dow officials have maintained that the herbicide is "not significantly hazardous to human or animal life," experiments conducted on laboratory monkeys at the University of Wisconsin have demonstrated that minuscule amounts of dioxin can cause hemorrhaging, hair loss, and miscarriage.

The effects of dioxin on humans have been documented by veterans who were exposed to Agent Orange in Vietnam. Among the symptoms that have been reported are skin lesions, swollen liver, numbness of the extremities, reduced sex drive, and personality disorders. After continued pressure from those men who fought in Vietnam, the Veterans' Administration ordered a fullscale epidemiological study on its effects.

Although 2,4,5-T was used in the United States as an herbicide for more than thirty years, by 1979 the Environmental Protection Agency had suspended its use in most cases after reports of ill effects on farmers and animals. However, the herbicide can still be used to dust rice crops and rangelands and to clear vegetation from airport run-ways, vacant lots, and the like.

Rolling Stone, 4 March 1982.

SUMMARY/HOMEWORK

1. Why is Agent Orange dangerous?
2. Why are the chemicals buried at Hyde Park resurfacing?
3. Why is the Hyde Park dumpsite said to be even worse than Love Canal?
4. Are all chemicals dangerous? Explain your answer.
5. Prepare a report on what dioxin does to humans.

LABORATORY WORKSHEET 3.10

NAME_____ CLASS_____ DATE_____

PROBLEM: How does water get into and out of the air?

MATERIALS: Paper towels, wire gauze, water, hot pad, 250 ml beaker, tin pie plate, ring stand and ring, tongs, alcohol lamp.

INTRODUCTION: Billions of tons of water fall on the surface of the earth every year in the form of rain and snow. About 1/4 of this water runs off the land and returns to the ocean. Another portion of this water evaporates into the air and later falls again as rain. Soil and plants absorb some of the water, and the remainder soaks into the earth as groundwater. The major elements of the water cycle are the fall of rain and snow to the earth, its evaporation, and its eventual return to the earth as rain or snow.

PROCEDURE

1. Moisten the backs of each of your hands with equal amounts of tap water. Record the time.

   _____

2. Fan one moistened hand with cardboard until it is completely dry. How long did it take to dry? _____

3. Was there any difference in temperature between your hands while you were fanning?

   _____

   _____

4. It took _____ for the unfanned hand to dry.

   What process did you just observe? _____

   Explain why one hand dried before the other. _____

   _____

   What is one way to speed up drying time?_____

   _____

LABORATORY WORKSHEET 3.10 (continued)

5. Following your teacher's instructions, set up an alcohol lamp [USE CAUTION!], wire gauze, ring stand and ring. Fill a beaker 1/3 full of water. Light the burner and heat the water until it almost comes to a boil. Extinguish the burner.

6. Place two ice cubes in a metal pie plate. Using tongs, hold the plate over the beaker of hot water (the flame is now out) for two minutes.

7. What do you observe forming between the bottom of the pie plate and the beaker?

_____

You have just demonstrated a process that takes place on Earth. What is it called?

_____

Explain why it happens. _____

_____

_____

SUMMARY/HOMEWORK

1. How do evaporation and condensation change the form of water?

2. What funishes the energy that operates the water cycle?

3. Why do windows inside a car fog up when several people first get into an automobile on a cold day?

LABORATORY WORKSHEET 3.11

NAME_____ CLASS_____ DATE_____

PROBLEM: What is the dew point and relative humidity of the air in the classroom?

MATERIALS: Shiny metal can, glass stirring rod, ice cubes, thermometers, beaker with water, cheesecloth, rubber band.

INTRODUCTION: As water evaporates from the Earth's surface it is stored in the air around us. Beyond a certain limit, air becomes saturated with water vapor and can hold no more. The amount of water vapor that the atmosphere can hold increases as the atmospheric temperature rises. When the air holds all the water it can, it is said to have a relative humidity of 100%. Warm air can hold more moisture than cold air. If the air is not saturated at a high temperature, it will become saturated when the temperature of air is lowered sufficiently. The excess water vapor will change to a liquid. The temperature at which this change first occurs is called the dew point.

PROCEDURE

1. To find the dew point of the air in the classroom do the following:

   a. Record the temperature of the air in the classroom.

   b. Fill the can halfway with water and add 2 ice cubes.

   c. Record the temperature of the water and stir gently with a glass rod for one minute. Do not stir with the thermometer.

   d. Examine the surfaces of the cans carefully. What do you see?

   _____

   _____

   e. Continue stirring and add more ice if necessary to lower the water temperature. Record the temperature at which you first observe condensation on the outside of the can.

   _____ °C.

   How many degrees is the dew point lower than the room temperature?

   _____

   _____

LABORATORY WORKSHEET 3.11 (continued)

2. Be careful using the thermometer. To find the relative humidity of the air in the classroom do the following:

   a. Record the air temperature. _____° C. This is called the "dry bulb" reading.

   b. Wrap a piece of cheesecloth around the bulb of the thermometer and fasten it with a rubber band. Dip the cloth into water at room temperature. Fan the cloth until the temperature no longer decreases. Be careful not to touch the bulb of the thermometer. Record this temperature as the "wet bulb" reading.

      _____°C.

   c. Subtract the two temperatures (2b from 2a) and record the difference.

      DRY BULB _____° - WET BULB _____° = _____°

   d. Using the relative humidity chart, determine the relative humidity of the air in the room.

      _____%

Differences in Temperature (°C)

Dry-Bulb Temperature (°C)	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
10	94	88	82	77	71	66	60	55	50	44	39	34	29	24	20	15	10	6	--	--
11	94	88	83	78	72	67	61	56	51	46	41	36	32	27	22	18	13	9	5	--
12	95	89	84	78	73	68	63	58	53	48	43	39	34	29	25	21	16	12	8	--
13	95	89	84	79	74	69	64	59	54	50	45	41	36	32	28	23	19	15	11	7
14	95	90	85	79	75	70	65	60	56	51	47	42	38	34	30	26	22	18	14	10
15	95	90	85	80	75	71	66	61	57	53	48	44	40	36	32	27	24	20	16	13
16	95	90	85	81	76	71	67	63	58	54	50	46	42	38	34	30	26	23	19	15
17	95	90	86	81	76	72	68	64	60	55	51	47	43	40	36	32	28	25	21	18
18	95	91	86	82	77	73	69	65	61	57	53	49	45	41	38	34	30	27	23	20
19	95	91	87	82	78	74	70	65	62	58	54	50	46	43	39	36	32	29	26	22
20	96	91	87	83	78	74	70	66	63	59	55	51	48	44	41	37	34	31	28	24
21	96	91	87	83	79	75	71	67	64	60	56	53	49	46	42	39	36	32	29	26
22	96	92	87	83	80	76	72	68	64	61	57	54	50	47	44	40	37	34	31	28
23	96	92	88	84	80	76	72	69	65	62	58	55	52	48	45	42	39	36	33	30
24	96	92	88	84	80	77	73	69	66	62	59	56	53	49	46	43	40	37	34	31
25	96	92	88	84	81	77	74	70	67	63	60	57	54	50	47	44	41	39	36	33
26	96	92	88	85	81	78	74	71	67	64	61	58	54	51	49	46	43	40	37	34
27	96	92	89	85	82	78	75	71	68	65	62	58	56	52	50	47	44	41	38	36
28	96	93	89	85	82	78	75	72	69	65	62	59	56	53	51	48	45	42	40	37
29	96	93	89	86	82	79	76	72	69	66	63	60	57	54	52	49	46	43	41	38
30	96	93	89	86	83	79	76	73	70	67	64	61	58	55	52	50	47	44	42	39
31	96	93	90	86	83	80	77	73	70	67	64	61	59	56	53	51	48	45	43	40
32	96	93	90	86	83	80	77	74	71	68	65	62	69	57	54	51	49	46	44	41
33	97	93	90	87	83	80	77	74	71	68	66	63	60	57	55	52	50	47	45	42
34	97	93	90	87	84	81	78	75	72	69	66	63	61	58	56	53	51	48	46	43
35	97	94	90	87	84	81	78	75	72	69	67	64	61	59	56	54	51	49	47	44
36	97	94	90	87	84	81	78	75	73	70	67	64	62	59	57	54	52	50	48	45
37	97	94	91	87	84	82	79	76	73	70	68	65	63	60	58	55	53	51	48	46
38	97	94	91	88	84	82	79	76	74	71	68	66	63	60	58	56	54	51	49	47
39	97	94	91	88	85	82	79	77	74	71	69	66	64	61	59	57	54	52	50	48
40	97	94	91	88	85	82	80	77	74	72	69	67	64	62	59	57	54	53	51	48

LABORATORY WORKSHEET 3.11 (continued)

3. Compare your results with those found by other groups and explain any differences.

_____

_____

_____

SUMMARY/HOMEWORK

1. Why can you be uncomfortable at 32° C one day and not be uncomfortable when the temperature is 32° C on another day?

2. What factors control relative humidity?

3. How are humidity, relative humidity, and dew point related?

4. Suppose the relative humidity is 30%. What does this mean? What does it mean if the relative humidity is 100%?

5. Why does the temperature of a wet bulb thermometer fall as the wet cloth is fanned?

6. How would you expect wet and dry bulb readings to compare when the relative humidity is 100%?

LABORATORY WORKSHEET 3.12

NAME_____ CLASS_____ DATE_____

Read the article carefully and answer the questions that follow.

Groundwater Pollution

More than 100 million people who drink water from underground wells may face the threat of consuming unhealthy chemical runoffs from industrial facilities or other polluting sources, a federal clean water official said on Friday.

"The problem is serious, for the intruding contaminants are often highly toxic, sometimes cancer-causing," warned Eckardt C. Beck, assistant administrator for water and waste management at the Environmental Protection Agency.

Beck told a House Government Operations subcommittee that although groundwater contamination is "very real and quite serious," there might be time to prevent further environmental damage, but action must be taken quickly.

He said that, traditionally, states bore the responsibility for groundwater, and only recently did federal statutes put EPA in the picture.

Now, he said, there are a number of federal regulations to deal with the purity of wells and other drinking water sources.

In addition, both houses of Congress are considering legislation setting up multimillion dollar "superfunds" to handle abandoned toxic waste dumps.

But Beck said the nation really needs a "coherent, integrated national approach" to get a real grip on the drinking water problem.

Beck cautioned of the severity of chemical seepage into the underground waterways.

"Our groundwaters, long considered virtually pollution-free, are threatened by ruinous contamination. The problem is national, for the potential sources and routes of contamination may be found wherever people live and work."

Beck said the pollutants originate from many places, including industrial plants, improper disposal of wastes from municipal facilities, landfills, agricultural spraying, highway deicing salts, mining, and septic tank cleaners.

"The likelihood of further deterioration nationally is clear," Beck stated, pointing out that chemicals oozing into the ground often are not cleaned out by nature, but could stay in the earth for an indefinite time -- perhaps forever.

Source: The Associated Press.

1. Why has contamination of groundwater become a serious problem?
2. Why is deterioration of groundwater supplies a problem?
3. What are some sources of groundwater pollution?
4. Choose two pollutant sources you believe to be most serious and explain why they are so serious.

LABORATORY WORKSHEET 3.13

NAME_____ CLASS_____ DATE_____

PROBLEM: How can water be purified for drinking?

MATERIALS: Test tubes, test tube rack, test tube holder, cloth, filter paper, screen, aluminum foil, clear plastic wrap, two beakers, alcohol lamp, container of dirty water.

INTRODUCTION: In some parts of the world drinking water is difficult to obtain. Although there may be a supply of water nearby, it can't be used because of the impurities it contains. Today you will perform an experiment designed to purify water by removing dissolved impurities.

PROCEDURE

1. Design a technique, using available equipment, to make dirty water fit to drink.

    a. What pollutants might be in the water supply?
    b. What pollutants should we remove first?

2. Write the procedure that a camper should follow to do this. (There is more space for writing on the next page.)

- -

PROBLEM: How can water be purified for drinking?

PROCEDURE

A. _____

_____

B. _____

_____

C. _____

_____

LABORATORY WORKSHEET 3.13 (continued)

D. _____

_____

E. _____

_____

_____

_____

_____

_____

_____

_____

3. How will you know if the water is pure after treatment?

_____

_____

4. Can all pollutants be removed by the process(es) used above? Why or why not?

_____

_____

SUMMARY/HOMEWORK

1. How is the water in our reservoirs similar to the sample of water you treated in your experiment?

2. How is the water in the reservoir made fit to drink?

LABORATORY WORKSHEET 3.14

NAME_____ CLASS_____ DATE_____

PROBLEM: How can we purify water?

MATERIALS: Test tube with fitted one-hole stopper into which a right angle delivery tube about 25 cm long has been inserted, ring stand, test tube clamp, alcohol burner, 50 ml graduated cylinder, three test tubes, 250 ml beaker, 10% sodium chloride solution, silver nitrate, ink, triple beam balance.

INTRODUCTION: Water purification is the process of cleaning water so that it is usable. Today you will learn about one means of purifying water, distillation.

PROCEDURE

1. With the members of your laboratory group, construct a distillation apparatus.

2. Place 10 ml of a 10% sodium chloride solution into the test tube and cap it, using a one-holed rubber stopper with a right angle tube in it.

3. Heat the test tube until almost all of the solution is gone. DO NOT BOIL UNTIL DRY. Measure the amount collected. _____ ml. How does this compare to the amount with which you started?

   _____

4. Test your distilled water with silver nitrate. Is there any salt in your distilled water? Explain.

   _____

5. How can you improve your apparatus to recover more water?

   _____

   _____

SUMMARY/HOMEWORK

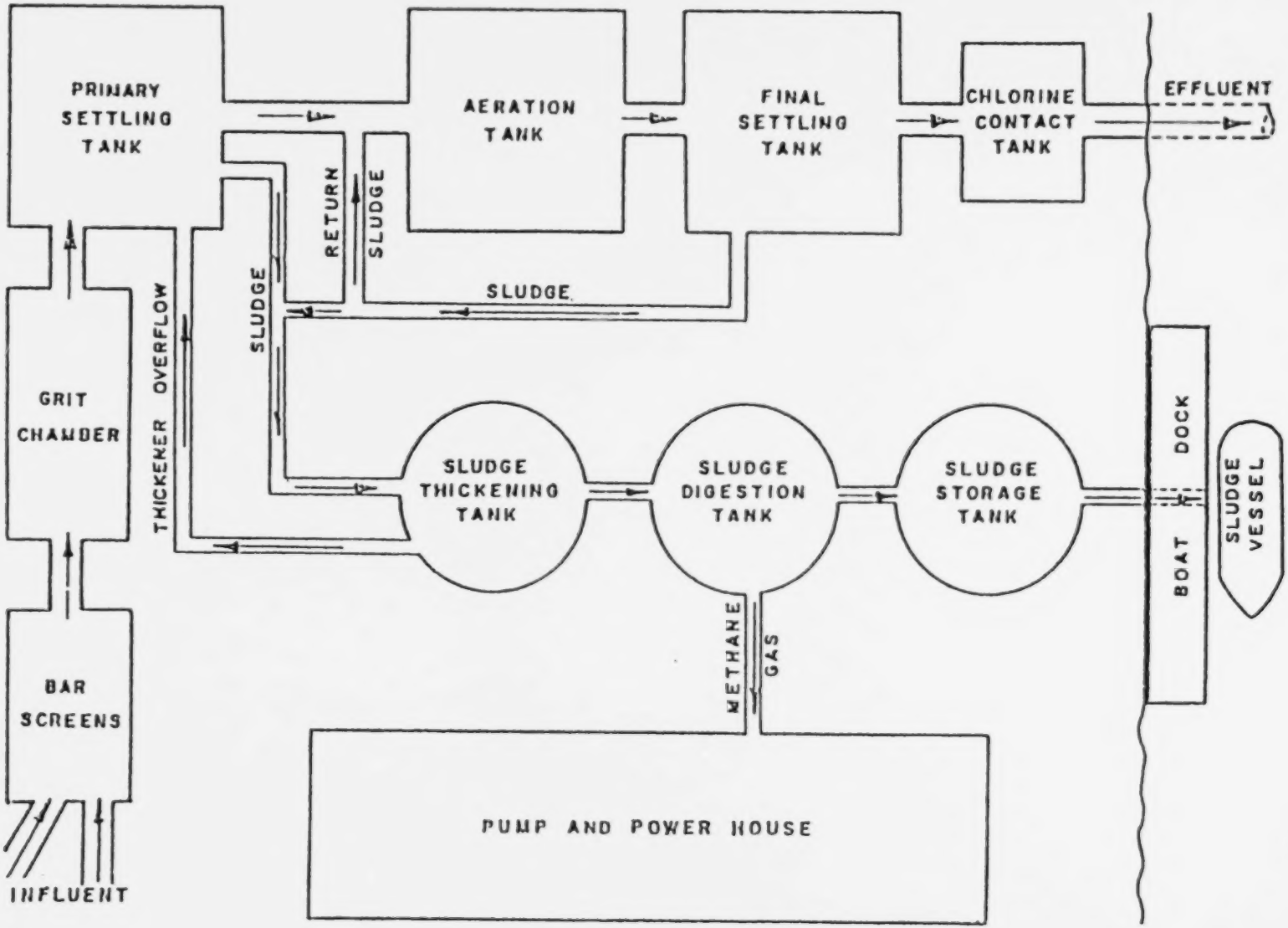
1. Why is there a need for water purification?

2. Which impurities can distillation remove from water?

3. Why is it impracticable to use distillation for large quantities of water?

LABORATORY WORKSHEET 3.15

Layout of a Typical New York City Water Pollution Control Plant



43

44

LABORATORY WORKSHEET 3.16

Operation of a Typical New York City Water Pollution Control Plant

Sewage is the waste water which has been polluted by home and industrial use. Until recently, the disposal of waste water was not considered to be a problem. Sewage was merely allowed to flow into the nearest body of water.

However, with a rapidly expanding population and a sharp increase in industrial wastes, the hazards of this practice became apparent. Large parts of the United States now have contaminated drinking water, disappearing marine life and water fowl, condemned bathing beaches, and the unsightly appearance of once-beautiful areas.

Water pollution control is essential now, and many systems of sewage treatment have been devised. They include septic tanks, Imhoff tanks, crushed stone trickling filters, sand filter beds, and activated sludge.

Septic tanks are widely used in areas where sufficient land is available for tank drainage and a central sewage system would be impractical. Imhoff tanks are used mainly by large institutions such as hospitals and schools which do not have access to a central sewer system.

Many cities and towns use trickling filters. These are relatively simple and effective, but require large areas that are not available in metropolitan communities such as New York City.

The choice of a sewage treatment system in a local community is determined by factors such as volume of sewage, availability of land, and the nature of the receiving waters into which the processed effluent is discharged. Circumstances dictate that the New York City plants must process large volumes of sewage with a high degree of efficiency, in very limited spaces, and often in close proximity to residential areas. These conditions can best be met by a treatment process using activated sludge. The operation of a typical New York City plant of this type is outlined below.

PRELIMINARY TREATMENT

The treatment process begins when the raw sewage, or INFLUENT flows through the BAR SCREENS, which consist of two series of upright bars spaced about one and three inches apart. Large objects, such as rags and sticks, are removed at the bar screens by automatic raking devices. Present bar screens consist of one set of bars spaced one inch apart.

A considerable amount of sand and gravel, or GRIT, enters the city sewer system through street drains, especially during rain. It is necessary to remove this grit soon after it enters the plant to protect pumps and other equipment from abrasion, and to prevent a build-up of grit deposits in subsequent treatment tanks. In older designs a GRIT CHAMBER was used to slow the velocity of the sewage to about one foot per second. At this reduced speed the heavier particles settle and are removed from the tank by a scraping mechanism. The lighter impurities which will require additional treatment, remain suspended in the sewage flow. In upgraded plants the grit chamber is no longer used. Instead, the grit is allowed to enter the PRELIMINARY SETTLING TANK with the sewage.

PRIMARY TREATMENT

The sewage is allowed to settle for about one hour in the PRIMARY SETTLING TANK. During this time about one-third of the suspended organic impurities settle and form a SLUDGE, which is removed from the bottom of the tank by pumps. A small amount of scum and grease rise to the top and is removed by a rotating mechanism that skims the surface. In plants where grit chambers are not present, grit settles in the primary settling tank and becomes mixed with the primary sludge. In order to separate the grit from the sludge, the mixture is pumped to a cyclone separator, where, under the action of centrifugal force and because of different specific weights, the two are separated.

SECONDARY TREATMENT

Secondary treatment begins in the AERATION TANK, where sewage is kept from three to six hours. During this time the sewage is supplied with compressed air from diffusers near the bottom of the tank.

The purpose of the aeration tank is to convert the dissolved and suspended solids into particles which will settle in a relatively short time. It is accomplished by AEROBIC BACTERIA, which thrive in the aeration tank due to the presence of oxygen and the organic impurities in the sewage which serve as their food supply. These bacteria build up around the particles of organic matter, and then, by the process of absorption, cause the individual particles to combine into clusters. Within these clusters most of the organic matter is either consumed by the bacteria or converted into simpler, stable compounds.

The bacterial clusters in the aeration tank, called FLOC, are able to settle rapidly.

The aeration tank is followed by the FINAL SETTLING TANK, where most of the sludge that settles is removed from the bottom of the tank by pumps. After two to three hours the clarified sewage, or FINAL EFFLUENT, flows from the plant into the receiving waters.

ACTIVATED SLUDGE

It is obvious that the number of bacteria in the aeration tank will determine the efficiency of the process. Although these bacteria multiply, they are constantly being lost as the sewage flows from the tank. As a result, unless more bacteria are added, the proportion of bacteria to suspended solids would be too low to achieve more than moderate treatment efficiency. The system of ACTIVATED SLUDGE solves this problem by returning some of the settled solids, or sludge, from the final settling tank to the aeration tank.

TREATMENT AND DISPOSAL OF REMOVED WASTES

The 12 operating water pollution control plants in New York City process over one billion gallons of sewage each day. Thousands of tons of sludge and solid matter are removed daily, and of course it is necessary to dispose of these wastes without adding to the pollution problems.

Grit, rakings from the bar screens, and the skimmings from the primary settling tanks are carried by truck to sanitation landfills. These substances however, make up only a small fraction of the material removed. Sludge, which contains most of the impurities removed from the sewage, requires additional treatment before it is finally disposed of.

THICKENING

In order to reduce treatment and transport costs, it is necessary to remove as much water as possible from the sludge. This is accomplished by placing the sludge in a special settling tank which is called a THICKENER. After settling for a period of 12 to 24 hours, a large amount of the water separates from the sludge. This water is returned to the sewage flow at the beginning of the plant and the remaining concentrated sludge, or THICKENED SLUDGE, is pumped from the bottom of the tank to the DIGESTER.

LABORATORY WORKSHEET 3.16 (continued)

DIGESTION

Because it consists of putrid solids, sludge cannot be used for landfill. Instead it is "digested" to reduce the pollution potential and is then shipped out to sea for disposal.

The DIGESTER is a large, enclosed, circular tank in which sludge is detained for a few weeks at a temperature of about 95 degrees. These conditions favor the growth of ANAEROBIC BACTERIA, which proliferate in the absence of oxygen. These bacteria obtain their nourishment by breaking down the organic compounds and in this manner convert about 50 percent of the organic matter in the sludge to various gases and water. The gas produced by digestion is composed essentially of METHANE and carbon dioxide, and many plants use it to generate all or most of their power.

The digested sludge is then pumped into a SLUDGE STORAGE TANK, where it will await shipment to sea by one of the City's four self-propelled sludge vessels. These ships, of varying capacities up to three thousand wet tons, (100,000 cu.ft.) dispose of the sludge about 12 1/2 miles out at sea, in a federally designated dumping area.

CHLORINATION

Even the most efficient water pollution control plant does not remove all of the impurities from the sewage. PATHOGENIC BACTERIA may be present in the plant effluent, and so, during the summer months the plants disinfect their effluent in order to protect local bathing beaches from contamination.

The most effective and economical disinfectant available for sewage treatment is CHLORINE. However, in its liquid and gaseous states chlorine is extremely dangerous and difficult to handle. Therefore, since 1965, New York City plants have applied chlorine in the form of SODIUM HYPOCHLORITE, which is stored in the plant in special tanks.

Disinfection takes place in the CHLORINE CONTACT TANK, where the plant effluent is detained for an average of 30 minutes in order to insure a thorough destruction of bacteria. The plant effluent is sampled frequently during the summer in order to assess the efficiency of disinfection. About 99.999 per cent of the coliform bacteria in the final effluent are killed by hypochlorination.

Answer the following questions:

1. What is sewage? _____

_____

LABORATORY WORKSHEET 3.16 (continued)

2. What are some methods of sewage treatment? _____

_____

3. What determines the kind of sewage treatment a community uses?

_____

_____

4. Briefly describe in your own words how sewage in New York City is treated.

_____

_____

_____

_____

_____

SCIENCE

DEATH IN THE SKY

Nestled within the spruce, pine and hemlock forests of New York's Adirondack Mountains, Brooktrout Lake glistens in deathly silence. No frogs croak and nothing moves under its crystal-clear surface. Twenty years ago, its serene waters gave up abundant trout, bass and pickerel to any angler who was willing to hike the 5 miles from the end of the nearest road, but today all traces of fish have vanished.

The fish in Brooktrout and scores of other lakes in the area were killed by acid rain—pollution produced when moisture in the atmosphere combines with oxides of sulfur and nitrogen emitted by power plants, factories and automobiles. Carried by prevailing winds, the acid clouds can jeopardize waterways, vegetation and even buildings thousands of miles from the industrial complexes that create them. Factories in Ohio and Indiana probably threaten the Adirondack lakes.

Brookhaven National Laboratory

Rain-damaged leaf

An acid haze over Alaska may originate in Japan. "Acid rain is a particularly alarming demonstration of the simple adage that what goes up must come down," said Colorado Sen. Gary Hart at a recent Washington hearing. "But what comes down is worse than what went up."

First identified as a problem by Swedish meteorologists in the 1950s, acid rain now pours down over vast tracts of the Northern Hemisphere. Most of the precipitation that falls on the eastern U.S. is as acid as tomato juice and some as acid as vinegar. Scientists have detected high levels of acidity in Los Angeles, San Francisco, Seattle and the Rocky Mountains. Even the tropical forests of Venezuela suffer from acid rainstorms. "What we see is frightening a lot of scientists," says researcher George Hendrey of the Brookhaven National Laboratory. "It's a lot worse than we thought."

It's also unlikely to get better soon in northern America. With the U.S. commitment to more coal-fired power plants, which emit oxides of sulfur, experts fear that the rain will become even more acid. In Canada, a recent government study estimated that within twenty years 48,000 lakes will be affected by acid rain.

Ironically, acid rain results partly from efforts to reduce pollution. Two decades ago, engineers intent on minimizing local smog in industrial regions began to erect increasingly tall smokestacks; one superstack towers 1,200 feet above a copper-nickel smelter in Sudbury, Ont. "The plume goes into the air mass at a higher location, so there is less of a mix with the local air," says Stephen Gage of the Environmental Protection Agency. "But that sets the stage for the current problem by transporting the pollution several thousand miles away to deposit it somewhere else."

Danger zone: Dead fish and corroded buildings

Fenga & Fraver

Most rain is somewhat acidic.* Because it contains dissolved carbon dioxide, which converts into carbonic acid, unpolluted rain possesses a pH of 5.6. Rain in the Adirondacks falls between 4.0 and 4.5 on the pH scale—more than ten times as acid as natural rain. A team from Cornell and Yale universities monitored one storm at Hubbard Brook, N.H., with a pH of 2.85—more than 500 times the normal, and acidic enough to seriously damage vegetation.

SHOCK: Intensive studies of the Adirondack lakes, begun in 1975, have revealed how acid rain harms aquatic life. Rapid introduction of large amounts of acid—during the spring melting of mountain snow, for example—can boost the acidity of lakes more than tenfold in a few days. This causes a shock from which hatching fish cannot recover. "Minnows and smaller fish disappear first," says biolgist Carl Schofield of Cornell University. Ichthyologists think that the acidity interferes in some way with the fishes' gills. It also disrupts their food chain. Increased acidity replaces normal plants that live on lake bottoms and shorelines with mosses and fungi and new types of algae.

Ecologists fear that acid rain may jeopardize more than marine life. "The potential is there for something far more serious—the possible effect on the fertility of soil," warns

*Scientists measure the acidity of rain with a criterion called pH. The scale of pH ranges from zero to fourteen; a value of seven represents the neutral point between acidity and alkalinity. The more acid the raindrop, the lower its pH. Because the scale is logarithmic, a drop of one in the pH value corresponds to a tenfold increase in acidity.

J. Georg—N.Y. State Department of Environmental Conservation

Attack on acid: Lacing a lake with lime

NEWSWEEK/OCTOBER 22, 1979

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LABORATORY WORKSHEET 3.17 (continued)

Richard Ayres of the Natural Resources Defense Council. "Thousands of square miles are undergoing loss of nutrients, washed away by the acid rain," agrees Brookhaven's Hendrey. Man-made structures, including great sculpture and architecture, are not immune to acid rain. "We don't know much yet about the corrosion of buildings," says Gene Likens of Cornell, "but economically this may be the biggest issue."

BALANCE: The impact of acid rain may be irreversible. Researchers are trying to reduce the acidity of lakes by dropping lime from helicopters, and they hope to breed more acid-tolerant fish. But just one thing will reduce the acid rain. "Limiting the emission of sulfur and nitrogen oxides, or eliminating them from fuel, seems to be the only way to deal with the problem," says Likens. If such a solution were achieved, it would still require years to restore the environmental balance. And few people expect even that first step to be taken anytime soon.

PETER GWYNNE with MARY HAGER in Washington and JOHN CAREY in New York and bureau reports

Newsweek, 22 October 1979.

1. What would be a better title for the article? Why?

_____

_____

_____

_____

2. Why might Michigan not have an area affected by acid rain?

_____

_____

3. Why is acid rain harmful?

_____

_____

4. How do scientists explain the formation of acid rain?

_____

_____

5. Why is the problem of acid rain getting so much attention now?

_____

_____

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LABORATORY WORKSHEET 3.18

NAME_____ CLASS_____ DATE_____

PROBLEM: How do dissolved minerals affect the water we use?

MATERIALS: Borax, Epsom salts, demineralized (distilled) water, tap water, hard water, liquid detergent, four test tubes with stoppers, test tube rack, 100 ml beaker, graduated cylinder, several (3) medicine droppers, metric ruler, transparent tape, paper for labels.

INTRODUCTION: The water you use could come from either an underground source or a surface source. The type of rock the water comes in contact with will determine if the water is "hard" or "soft." Hard water contains large amounts of dissolved mineral compounds containing magnesium, calcium, and other substances. Practically speaking we can say that soft water does not contain these minerals. Today we will test how hard and soft waters affect the cleaning action of soaps.

PROCEDURE

1. Place 25 ml of tap water (room temperature, 20°C) in a test tube; label it tube A.

2. Place 25 ml of warm tap water (40°C) in another test tube; add some borax and $Ca(HCO_3)_2$; insert stopper. Label this tube B.

3. Place 25 ml of warm tap water and some Epsom salt ($MgSO_4$ $7H_2O$) in a test tube. Label this tube C.

4. Place 25 ml of demineralized (deionized) water in a test tube. Label this tube D.

5. Place five drops of soap solution into each test tube. Place a rubber stopper in each tube and shake each test tube for 30 seconds. Measure the height of suds in the tube. In each case, record your results on the following chart. In the column on the right, rate each tube from 1 to 4 according to its sudsing power (1 = most sudsy; 4 = least sudsy).

LABORATORY WORKSHEET 3.18 (continued)

	Height of suds	Appearance	Rating
Tube A			
Tube B			
Tube C			
Tube D			

6. Which tube was the control? _____

7. Which tube contains the hardest water? _____

8. Which tube contains the softest water? _____

9. What do you conclude from this experiment? _____

_____

_____

_____

SUMMARY/HOMEWORK

1. Why is soft water better for home use than hard water?

2. What type of water do you have at home? How can you tell?

3. Write a report on how hard water can be softened.

4. Design a follow-up experiment using: (a) different soaps, (b) varying concentrations of the same "mineral," i.e., Borax, (c) water softeners available at the supermarket, (d) a soap compared to a detergent.

LABORATORY WORKSHEET 3.19

NAME_____ CLASS_____ DATE_____

PROBLEM: How is air pressure measured?

INTRODUCTION: A barometer is an instrument that is used to measure air pressure. The aneroid barometer consists of a metal box with a thin corrugated cover, from which most of the air has been removed. When air pressure increases, it pushes the top of the box downward, causing the pointer to move in one direction. When air pressure decreases, the top of the box moves upward, causing the pointer to move in the opposite direction. Today we will construct an aneroid barometer.

MATERIALS: Construction paper (28 cm x 21.5 cm), coffee can (empty), plastic drinking straw, plastic wrap (16 cm x 16 cm), large rubber band, transparent tape, rubber sheet or balloon.

PROCEDURE

1. Cut and prepare a piece of construction paper as shown in diagram A to provide a gauge by which changes in air pressure can be measured.

2. Mark the edge of the paper as shown. These marks should be 2 mm apart. Write the words HIGH and LOW on the paper as indicated.

3. Cover the top of an empty coffee jar or can with a rubber sheet (a balloon may be used). Secure this with a rubber band.

4. Attach the construction paper and coffee can as shown in diagram B.

5. Flatten one end of a plastic straw to act as a pointer. Gently tape it to the center of the stretched cover of the can.

6. Record the movements of the straw at various points in the building:

Basement _____ Second floor _____

First floor _____ Third floor _____

If the temperature is kept constant, the straw should move in response to changes in air pressure. When the straw moves downward the pressure is decreasing. When the straw moves upward the pressure is increasing.

LABORATORY WORKSHEET 3.19(continued)

7. Record the air pressure in the classroom _____

   Record the air pressure in the classroom the next day _____

   Was there a difference? If so, can you explain why?

   _____

   _____

SUMMARY/HOMEWORK

1. Explain the principle of the barometer.
2. Why does the air pressure differ in various parts of the building?
3. What kind of weather is generally associated with high pressure?

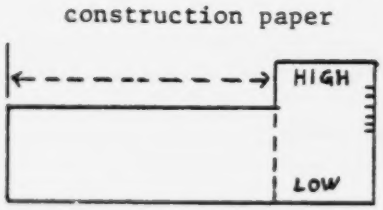
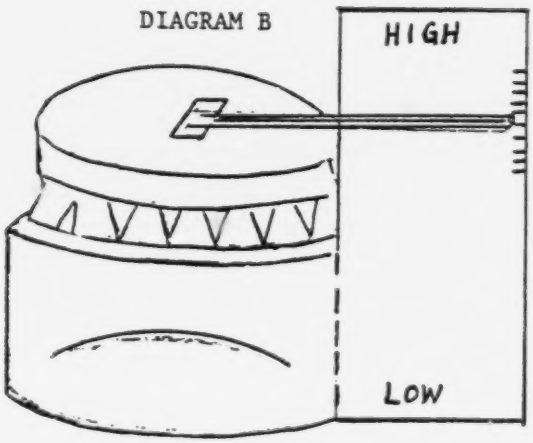


DIAGRAM A

DIAGRAM B



LABORATORY WORKSHEET 3.20

NAME_____ CLASS_____ DATE_____

PROCEDURE

Read this passage about the effects of air pollution and answer the questions that follow.

The Effects of Air Pollution

A simple definition for air pollution is "man-made contamination of the environment." Air pollution has significant negative effects on all forms of living and non-living things.

The effects of air pollution may be very quick and apparent, such as deaths caused by a single dose of poison gas. They may also be the result of continuous extended exposure such as a form of lung cancer caused by asbestos. These effects are particularly insidious, since they may occur years after the exposure.

Frequently, pollution from two or more sources in combination have an effect much greater than the sum of their individual effects. An example of this synergistic effect is that both ozone and nitrous oxide are pollutants that can irritate our lungs. When these two are inhaled together, the results can be disastrous.

When we think about the effects of pollution, we are usually concerned primarily about the effects on human health. Such effects range from heavy smog causing respiratory distress or even death to the general population, to the effect of carbon monoxide poisoning upon a single individual. Often the time and degree of exposure will determine the extent of the damage to health.

Besides physical illness and death, there are other effects that are just beginning to be described and studied. Among these are the psychological effects of unpleasant living conditions and the possible genetic effects of radiation or toxic chemicals.

Damage to other living things is no less serious. Death and disease of livestock, crops and forests is not only an economic loss, but diminishes world resources, including the crucial food supply in developing nations.

LABORATORY WORKSHEET 3.20 (continued)

Pollution also has an adverse effect on structural materials. Most metals corrode faster in a polluted environment. For example, steel corrodes 30 times as fast. Stone buildings are literally dissolving and valuable monuments are being destroyed. Cleopatra's Needle has been behind the Metropolitan Museum since 1880, and it has deteriorated more since then than it did during the 3,000 years it spent in the deserts of Egypt.

All of the above effects have an economic cost. Recently estimates put economic damage in the United States at the following levels per year:

Human health costs	$20.1 billion
Residential property costs	6.2 billion
Other property costs	5.1 billion
Crops and livestock cost	1.0 billion

This averages out to several hundred dollars per family per year.

The least direct, yet probably most serious effect of air pollution, is its effect on the ability of the Earth to sustain life as we know it. The extent of the damage to the crucial and fragile balance of the biosphere, the life-supporting portion of the Earth, has not yet been estimated, although we know that CO_2 from fossil fuel burning is changing Earth's climate.

1. What is meant by the synergistic effects of pollution? Give an example.

_____

_____

2. Give an example of each:

   a. Short-term effect of pollution

   _____

   b. Long-term effect of pollution

   _____

   c. Possible, but not yet verified, effect of pollution

   _____

LABORATORY WORKSHEET 3.20 (continued)

3. Give an example of each:

   a. Air pollution effect on health

   _____

   b. Air pollution effect on the economy

   _____

   c. Air pollution effect on materials

   _____

4. Why has the effect of air pollution on the biosphere been said to be the most serious threat to our environment?

   _____

   _____

   _____

LABORATORY WORKSHEET 3.21

NAME_____ CLASS_____ DATE_____

1. Who in New York City enforces our laws against air pollution? (Since 1969, the New York City Department of Air Resources has produced a Daily Air Pollution Index. It describes pollution levels in the City during the 24 hours preceding the report [from 3 p.m. the previous day to 3 p.m. the current day]. They describe the air quality as follows:)

   a. Good -- levels for the day were at or below the Federal standard.

   b. Acceptable -- although the Federal standard was not met, the levels are not so high as to jeopardize meeting that standard over the course of a year.

   c. Unsatisfactory -- if these levels were to occur over a substantial number of days, the standard would not be met.

   d. Unhealthy -- refers to chronic, not short-term exposure to levels above the Federal standard.

   * A Study of the Air Pollution Index for New York City
   (data represents the number of days for a given year)

Pollution Level	1969	1970	1971	1972	1973	1974	1975	1976
Good	0	0	61	58	48	108	107	151
Acceptable	38	86	198	252	229	193	204	121
Unsatisfactory	209	196	80	48	65	27	23	49
Unhealthy	114	79	26	7	23	36	19	45

2. What changes have occurred in the air quality in New York City over the eight years represented in the chart?

_____

_____

3. What possible reasons are there for these changes?

_____

_____

LABORATORY WORKSHEET 3.21(continued)

4. What can cause "unsatisfactory" and "unhealthy" conditions in New York City?

_____

_____

5. Until recent years, sulfur dioxide was a major pollutant in New York City. Why has this changed?

_____

_____

LABORATORY WORKSHEET 3.22

NAME_____ CLASS_____ DATE_____

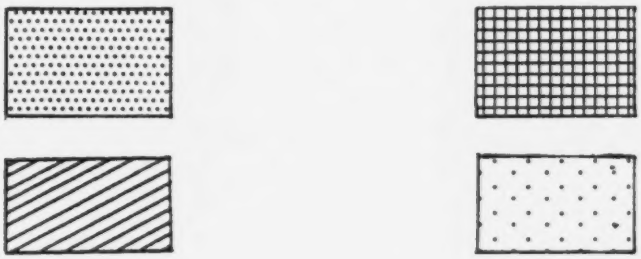
PROBLEM: What solid pollutants can we find in our air?

INTRODUCTION: Your task today will be to identify the pollutants that are on the air pollution detection tapes that you exposed in Lesson 6. Your information will be pooled along with that of your classmates. The data may reveal that your neighborhood has an air pollution problem and might lead you to the source of it.

MATERIALS: Slides of air samples, hand lenses, solid air pollutant slides, (cigarette ash, car exhaust, dust, chimney exhaust, etc.).

PROCEDURE

1. Examine the "known" slides that are on the demonstration table.



2. Draw what is on your tape:

Date _____

Time began _____

Time ended _____

Sample taken at _____

LABORATORY WORKSHEET 3.22(continued)

3. My pollution tape showed the presence of _____

_____ and _____

4. What types of particles were present in the largest amount?

_____ and _____

5. This chart is to be completed by all groups reporting:

Location	Time of Day	Particles	Weather Condition

SUMMARY/HOMEWORK

1. The dirtiest place was _____

2. The particulate matter found most often by the class was

_____

3. What effect will the weather have on particulate matter? For example:

windy conditions: _____

rainy conditions: _____

LABORATORY WORKSHEET 4.1

NAME_____ CLASS_____ DATE_____

PROBLEM: How has life expectancy changed from 1900 to today?

MATERIALS: Colored pencils.

INTRODUCTION: One rapidly expanding area in the health field has been the growing number of jobs in nursing homes. An entire new branch of medicine called geriatrics has developed to care for older people. Why do you think this is happening more in recent years than 80 years ago?

PROCEDURE

1. Use the information from the data table to do the following using different colored pencils or pens:

   a. Plot the points on the graph for the total ages of life expectancy for each given year from 1900 to 1980. Then connect these points with a solid line. (_____)

   b. Plot the points on the graph for male life expectancy for each year. Then connect these points with a series of dashes. (- - - -)

   c. Plot the points on the graph for female life expectancy for each year. Then connect these points with a series of dots. (.....)

2. Answer the following questions based upon information in the graph. (Use full sentences.)

   a. How have total life expectancies been changing since 1900?

   _____

   _____

   _____

   b. What could you predict happening to the total life expectancy in the next 100 years?

   _____

   _____

LABORATORY WORKSHEET 4.1 (continued)

NAME_____

c. Explain what has been happening to the trend in life expectancy since 1950.

_____

_____

d. Compare life expectancy of men to that of women. Hypothesize as to why these differences exist.

_____

_____

_____

_____

SUMMARY/HOMEWORK

. Give reasons for the changes in life expectancies in the past 100 years.

LABORATORY WORKSHEET 4.1 (continued)

Name _____ Class _____ Date _____

PROBLEM:

What has happened to life expectancy from 1900 to today?

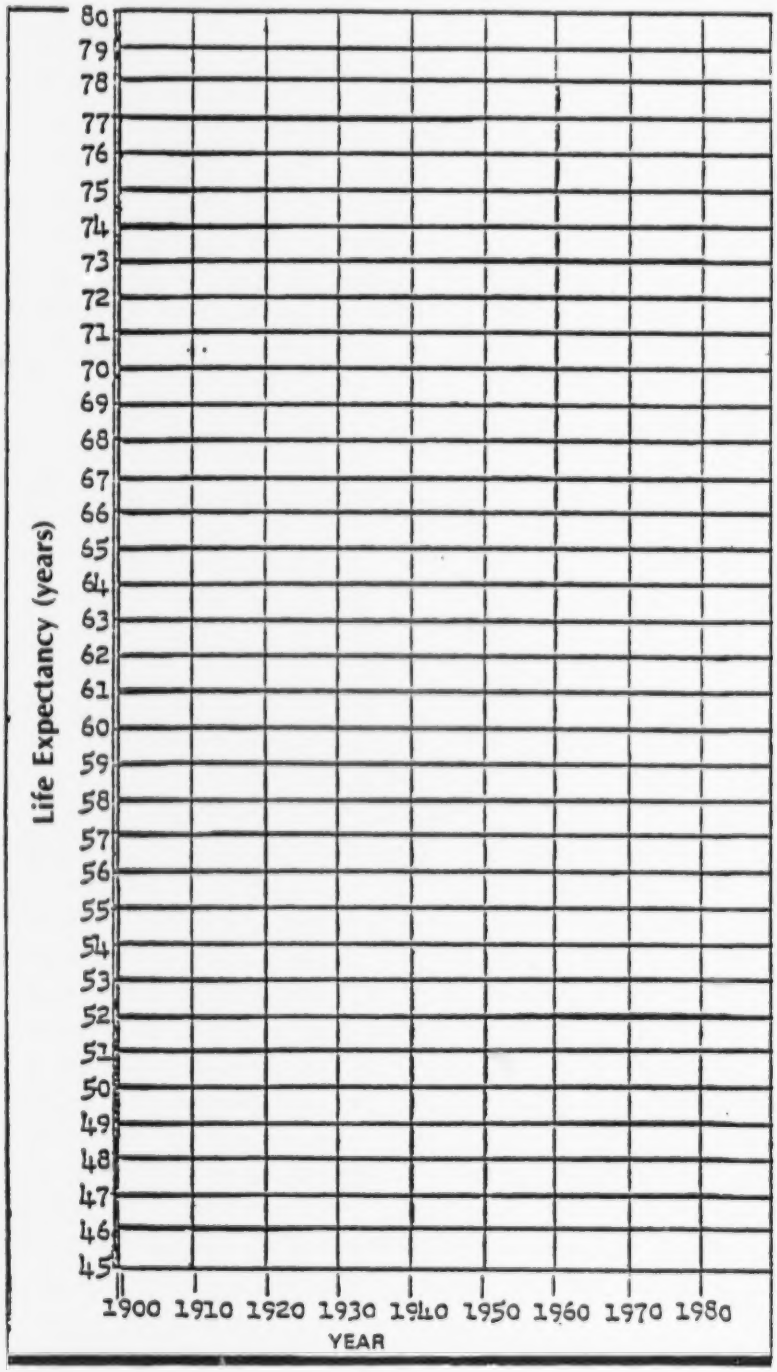
DATA TABLE *
Life Expectancy (years)

Year	Total	Male	Female
1900	47	46	48
1910	50	48	52
1920	54	54	55
1930	60	58	62
1940	63	61	65
1950	68	66	71
1960	70	67	73
1970	71	68	75
1980	74	70	78

* NOTE: Figures have been rounded off to the nearest whole numbers.

KEY:
_____ Totals
- - - - - - - - - Males
. . . . . Females

Follow the directions given in Procedure No. 1



LABORATORY WORKSHEET 4.2

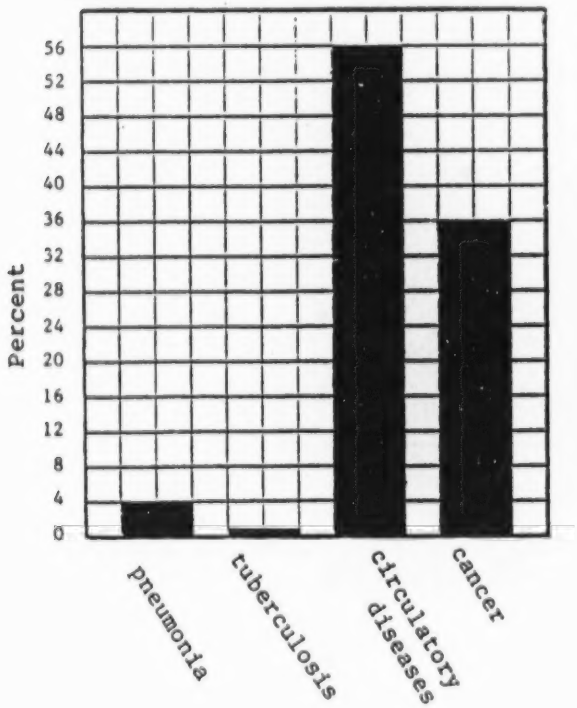
NAME_____ CLASS_____ DATE_____

PROBLEM: How do the causes of death in the United States today compare to those in 1900?

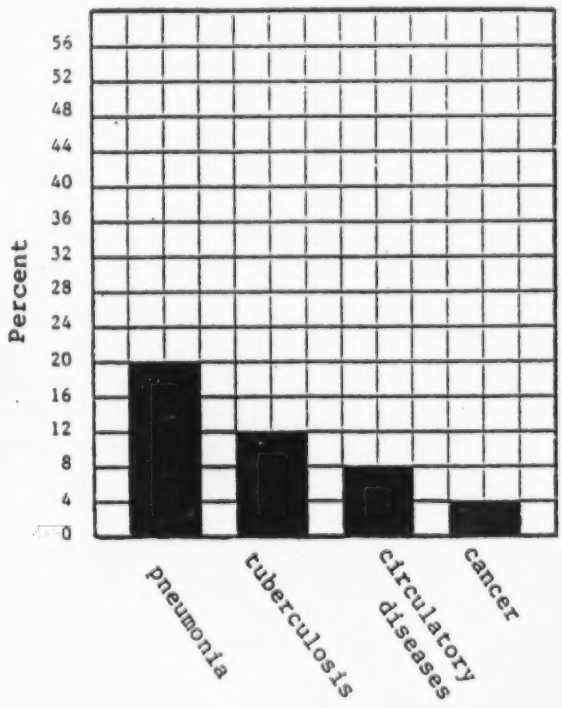
MATERIALS: None.

INTRODUCTION: If you were to read an obituary column from a newpaper dated 1900, you would find the causes of death of individuals to be different than if you picked up an obituary column from a current newspaper. What were those diseases in 1900, how do the main causes of death today differ, and why has this changed, are the questions you will answering today.

Major Causes of Death
in the United States in 1980



Major Causes of Death
in the United States in 1900



LABORATORY WORKSHEET 4.2 (continued)

NAME_____

PROCEDURE

1. What was the leading cause of death in the United States in 1900? _____

   What percentage of deaths resulted from this cause? _____

2. What was the second leading cause of death in the United States in 1900?

   _____

   What percentage of deaths resulted from this cause? _____

3. What was the total percentage of people who died from both these diseases in 1900? _____

4. What was the leading cause of death in the United States in 1980? _____
   What percentage of total deaths in 1980 resulted from this cause? _____

5. What was the second leading cause of death in 1980? _____

   What was the percentage of deaths from this cause? _____

6. What was the total percentage of people who died from both these diseases in 1980? _____

7. What has been the pattern of change for each of these diseases from 1900 to today?

   pneumonia _____

   tuberculosis _____

   cancer _____

   circulatory diseases _____

   How do you explain these changes?

   _____

   _____

   _____

LABORATORY WORKSHEET 4.2 (continued)

NAME_____

8. How can the information in these graphs explain one of the main reasons people in the United States live longer today than they did in 1900?

_____

_____

_____

9. How can we explain the low incidence of circulatory disease and cancer in 1900?

_____

_____

_____

SUMMARY/HOMEWORK

- Most of the money being spent on medical research today is being used to support investigations into circulatory diseases and cancer. Do you think this money is being well spent? Why?

LABORATORY WORKSHEET 4.3

Prevention of Cancer

A dramatic reduction in the rate of cancer is now possible, thanks to a shift of emphasis towards prevention. A prevention program could cut cancer as much as 50%. The view is now widely held that a large majority of cancers--perhaps as much as 90%--is caused by exposure to environmental chemicals.

CAUSES OF CANCER: RADIATION

This showed up as early as the 1920s in the illness of workers painting radium on watches. The survivors of atomic bomb attacks on Hiroshima and Nagasaki suffer a high rate of leukemia and breast cancer.

CAUSES OF CANCER: TOBACCO

Modern research has identified at least seven carcinogens in tobacco smoke and found that 80% of all lung cancer is due to cigarette smoke.

CARCINOGENS IN THE WORKPLACE

A study by the National Cancer Institute and National Institute of Environmental Health Sciences found that at least one of every five future cases of cancer will come from exposure to carcinogens on the job. The worst offender seems to be asbestos, with the number of cancers related directly to asbestos exposure reaching an estimated 67,000 each year during the next 30-35 years

Some other examples:

. Rubber workers, exposed to multiple-cancer causing substances, such as vinyl chloride, are dying of cancers of the stomach and prostate and of leukemia and other cancers of the blood and lymph forming tissues at "rates ranging from 50% to 300% greater than in the general population."

. Steelworkers handling coal at coke ovens have excessive rates of lung cancer.

. Workers in dye factories using benzidene and other aromatic amines have a high rate of bladder cancer.

. Miners of uranium, iron ore, nickel, chromium and other industrial chemicals are likely to get industry-related cancers. Fifty percent or more of uranium miners die of lung cancer.

. About two million workers, including dry cleaners, painters, printers and rubber and petroleum workers, are exposed to the solvent benzene, identified as a leukemia-producing agent.

. Another 1.5 million workers, handling insecticides and working in copper and lead smelters, are exposed to inorganic arsenic, a carcinogen related to lung and lymphatic cancer.

In addition, chemical carcinogenic wastes from industry are leaking into food, water, and the air. Measurable amounts of PCB were found in the milk of almost one-third of all nursing mothers tested in 1975.

Abstracted from "Health," Social Issues Resources Series, Vol. 2, Article 5.

LABORATORY WORKSHEET 4.3 (continued)

NAME_____ CLASS_____ DATE_____

DIRECTIONS: Based on the article, "Prevention of Cancer" answer the questions which follow.

1. How can the number of cancer cases in the future be reduced?

2. What do scientists believe causes cancer?

3. What are carcinogens?

4. What effect did the atomic bomb have on the people of Hiroshima and Nagasaki?

LABORATORY WORKSHEET 4.3 (continued)

NAME_____

5. Explain the following in a brief paragraph: Technological advances improved our lives with new products. Are we paying the price of progress with our lives and health?

LABORATORY WORKSHEET 4.4

NAME_____ CLASS_____ DATE_____

PROBLEM: How do we use the microscope?

INTRODUCTION: Many of the secrets of life have been revealed with the aid of the microscope. Hopefully, once you learn how to use the microscope, a new and fascinating world will open for you.

MATERIALS: Microscope, lens paper, charts of microscope.

PROCEDURE

1. The microscope is an expensive instrument that must be used with proper care. Whenever you use a microscope you must always keep in mind the following basic rules:

   a. Always carry or lift the microscope using both hands; one hand on the arm, the other hand under the base.

   b. Always place the microscope in the center of your table with the arm towards you.

   c. Never touch or clean the lenses with anything except special lens paper.

   d. Before putting the microscope away, turn the nosepiece so none of the objectives are in line with the body tube. This is called the neutral position.

   e. As you learn to use the microscope, there will be other safety rules that you will learn.

2. You are now ready to get your microscope. Follow the rules learned in Procedure 1. When you have your microscope properly placed in front of you, begin to read the next paragraph.

   Read the following selection, then answer the questions.

   The microscope which you are using is called a light compound microscope. It is called a light microscope because it uses light as its source of energy. The parts of the microscope which furnish light or direct it into the microscope are called the illuminating parts. Microscopes use lenses to magnify objects. Your microscope is called a compound microscope because it contains two or more sets of lenses. The parts of the microscope which help magnify the object are called the optical parts. The parts which help support it and focus it are called the mechanical parts.

LABORATORY WORKSHEET 4.4 (continued)

NAME _____

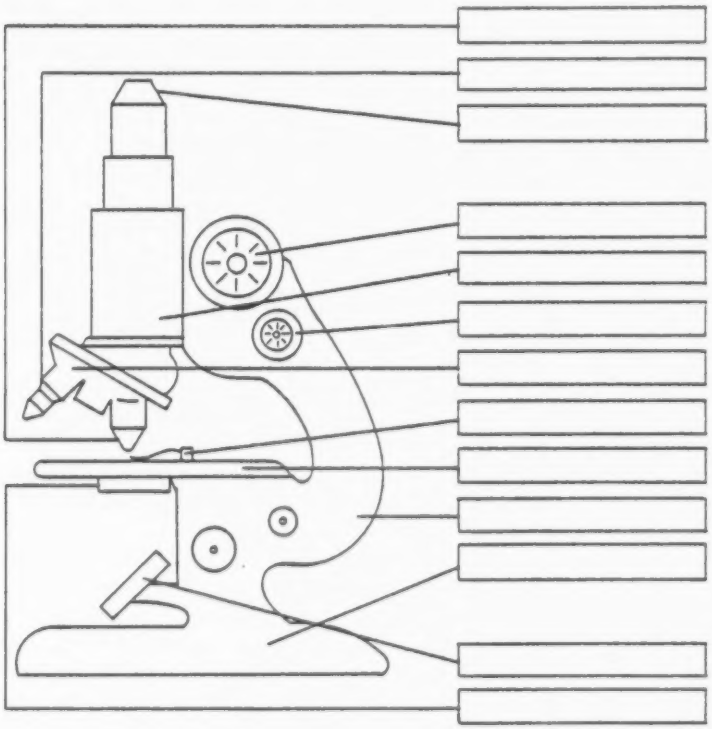
As you read the description of the parts of the microscope, locate each part on your microscope. When you are sure that you have correctly located a part write in its name on the diagram of the microscope. It is important not to move any of the parts of the microscope.

It is best to try to locate each part from the description alone. If you are having a great deal of difficulty it is all right to use the charts or diagrams that your teacher can provide for you.

a. Write a definition of the light compound microscope. _____

_____

b. Fill in the boxes of the microscope diagram according to optical, mechanical, and illuminating parts. Do this as you read about the parts of the microscope.



Parts of the Microscope

NAME_____

I. The Illuminating Parts

A. Mirror - The mirror is arranged so that it can reflect light up through the microscope. Your mirror may have both a flat side and a (concave) curved side. It is best to use the flat side for light coming from a distance (windows), while the concave side is best for light from a nearby lamp.

B. Diaphragm - The diaphragm is located on the underside of the microscope above the mirror. The diaphragm regulates the amount of light that reaches the microscope. It may be a disk with holes of different sizes, or it may be an adjustable iris which gets larger or smaller as a lever is moved.

II. The Optical Parts

A. Eyepiece - The eyepiece is a combination of lenses at the top of the microscope. It is the part of the microscope which you look into.

B. Objectives - These are the sets of lenses located at the bottom of the tube. There are at least two objectives on your microscope. The larger one is called the high power objective. The shorter one is the low power objective.

III. The Mechanical Parts

A. Base - A heavy base supports the microscope and enables it to stand upright on your table.

B. Arm - The arm is the part of the microscope which looks like a handle and can be used to carry the microscope.

C. Stage - The stage is a platform on which the specimen rests. The stage has a round hole in its center through which light can pass.

D. Stage Clips- These are small metal clips which are located on the stage. They are used to hold the glass slides in place.

E. Body Tube - A long tube which holds the eyepiece lenses.

F. Nosepiece - The nosepiece holds the objectives. It can be rotated to change from one objective to another.

G. Coarse Adjustment Knob - A large knob or wheel used to focus the microscope.

H. Fine Adjustment Knob - The small knob or wheel that enables you to make small adjustments and obtain the clearest focus possible.

LABORATORY WORKSHEET 4.4 (continued)

NAME_____

3. Now you are ready to learn how to use the microscope. Be sure to carefully follow all the instructions. Write in the answers to the activities in the space provided.

The Optical Parts

a. Examine the eyepiece at the top of the microscope. What is written on the eyepiece?_____

b. What do the numbers tell you about the function of the eyepiece?

_____

c. Locate the objectives on the nosepiece at the bottom of the body tube. Examine the two (2) objectives carefully and indicate on the chart below two (2) ways you can tell the low and high power objectives apart.

Low Power	High Power

d. How can you switch from one objective to another?_____

_____

e. How do you know if your objective is in the correct position for viewing?_____

_____

Practice switching from low power to high power. When you are finished leave the low power objective in place.

Determining Total Magnification

The total magnification of a microscope is equal to the magnification of the eyepiece times the magnification of the objective being used.

a. Determine the total magnification of your microscope for low power.

Low power objective X Eyepiece = Total Magnification

_____ X _____ = _____

LABORATORY WORKSHEET 4.4 (continued)

NAME_____

b. Determine the total magnification of your microscope for high power.

High power objective	X	Eyepiece	=	Total Magnification
_____	X	_____	=	_____

4. The Illuminating Parts

a. Examine the mirror and see in which directions it swivels.

b. Turn the mirror to the correct side, depending on your light source (the flat side for light coming from a distance through windows; the curved (concave) side for light from a nearby lamp).

c. Use the mirror to direct light to the tip of the low power objective. CAUTION: NEVER USE DIRECT SUNLIGHT FOR LIGHTING THE SUBJECT YOU ARE VIEWING. IT MAY CAUSE PERMANENT DAMAGE TO YOUR EYES.

d. Look into the eyepiece. Describe what you see._____

_____

e. The area that appears is called the field of vision. Try turning the mirror slightly, until the brightest field of vision is obtained.

f. While looking through the eyepiece turn the diaphragm slowly to the left and right. What happens to the field of vision as you do this?

_____

_____

5. The Mechanical Parts

a. Find the coarse adjustment knob. Turn the coarse adjustment knob slowly towards you. In what direction did the body tube move?

_____

_____

b. Turn the coarse adjustment knob slowly away from you. In what direction did the body tube move?

_____

_____

LABORATORY WORKSHEET 4.4 (continued)

NAME_____

CAUTION: YOU SHOULD NEVER TURN THE COARSE ADJUSTMENT KNOB AWAY FROM YOU WHILE LOOKING THROUGH THE EYEPIECE.

c. Why is this an important safety rule to remember?_____

_____

d. Turn the fine adjustment knob slowly toward you and away from you, while looking through the body tube. Does the body tube move?_____

The body tube actually did move, but such a small distance that it was impossible for your eye to see it.

CAUTION: NEVER TURN THE FINE ADJUSTMENT KNOB MORE THAN ONE TURN IN EITHER DIRECTION.

SUMMARY/HOMEWORK

1. Indicate the location and functions of each of the following parts:

a. stage:_____

_____

b. arm: _____

_____

c. base: _____

_____

d. stage clips:_____

_____

e. body tube:_____

_____

LABORATORY WORKSHEET 4.5

NAME_____ CLASS_____ DATE_____

PROBLEM: How is the microscope properly used?

INTRODUCTION: You are now ready to use your microscope to observe an object. Follow the directions carefully, and perform the activities as directed. If you have any difficulty, remember to ask your teacher for help.

MATERIALS: Microscopes, letter "e" slides, assorted optional slides (blood cells, plant cells, animal cells, etc.)

PROCEDURE

1. Setting up the Microscope under Low Power

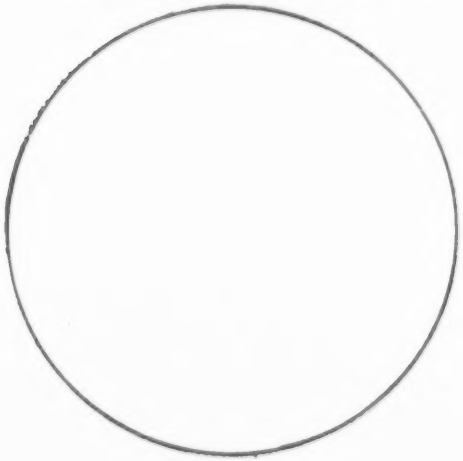
   a. Set the microscope up for use under LOW power.

   b. Ask your teacher for a prepared slide of the letter "e." Place the slide of the letter "e" on the stage of the microscope so that you can read the letter "e" in its normal position. Be sure that the letter "e" is placed in the center of the stage. Secure the slide to the stage by means of stage clips.

   c. While looking at the microscope from one side, slowly turn the coarse adjustment knob away from you to lower the body tube, until the objective is almost touching the slide.

   d. Look through the eyepiece and while doing so, turn the coarse adjustment knob VERY SLOWLY toward you until the letter "e" comes into focus. (If you do not succeed start over again). Use the fine adjustment to sharpen the focus.

   e. In the space provided, draw the letter "e" as it appears under the low power of the microscope.



The Letter "e" as seen under Low Power

LABORATORY WORKSHEET 4.5 (continued)

NAME_____

f. How does the letter "e" as viewed under the microscope differ from the letter "e" that you see with your naked eye?

_____

_____

2. The Movement of an Image Under the Microscope

a. Move your slide to each of the positions listed below and indicate in which direction the image moves.

Move slide to the right	Image moves to the_____
Move slide to the left	Image moves to the _____
Move slide towards you	Image moves_____
Move slide away from you	Image moves_____

b. Make a general statement about the movement of the image under a microscope.

_____

_____

3. Setting up the Microscope under High Power

a. After you have completed the previous activities, carefully turn the nosepiece until the high power objective clicks into place. (NOTE: There should be no difficulty in doing this if your microscope is in good condition. On some old microscopes, however, it may be necessary to raise the body tube a little to prevent the high power objective from hitting the slide.)

b. While looking through the microscope, use the fine adjustment knob to bring the image into focus. (CAUTION: YOU SHOULD NEVER USE THE COARSE ADJUSTMENT KNOB WHEN VIEWING UNDER HIGH POWER.) Since high power requires more light than low power it may be necessary to adjust the mirror or diaphragm again in order to get the greatest amount of light.

c. If necessary move your slide to center your letter "e." It may be necessary to go back to low power if you cannot find the letter "e". (NOTE: Remember that if an object is not centered and focused under low power first, you will not be able to see it under high power).

LABORATORY WORKSHEET 4.5 (continued)

NAME_____

d. Why should you never use the coarse adjustment knob when viewing an object under high power?

_____

_____

e. In the space provided, draw the letter "e" as it appears under the high power of the microscope.

The letter "e" as seen under High Power

b. How does the image under high power differ from the image under low power?_____

_____

6. (Optional) Ask your teacher to give you the set of glass slides which have on them some of the things Leeuwenhoek originally discovered.

SUMMARY/HOMEWORK

1. Given a prepared slide of a tiny organism, briefy describe how you would locate the organism under high power.

2. Explain why objects are frequently lost when switching from low power to high power.

LABORATORY WORKSHEET 4.6

NAME_____ CLASS_____ DATE_____

PROBLEM: How can we observe bacteria under the microscope?

INTRODUCTION: Bacteria are the most numerous organisms on the earth. They are also the smallest and the simplest in structure. Since they are normally colorless, slides of bacteria are frequently stained. Stains color cells and make them easier to observe.

None of the bacteria you observe should be harmful, but whenever you study bacteria you should be careful and treat all bacteria as if they cause disease.

MATERIALS: Microscope, slides, cover slips, medicine dropper, methylene blue solution, a container of plain yogurt, prepared slides of bacteria, lens paper, test tubes, chart of shapes of bacteria.

PROCEDURE

1. Examination of yogurt.

   a. Place a drop of methylene blue stain on a carefully cleaned slide and allow to dry for three minutes.

   b. In a clean test tube add 1 drop of yogurt to 9 drops of water. Mix well.

   c. Add a drop of the diluted yogurt to the stained slide.

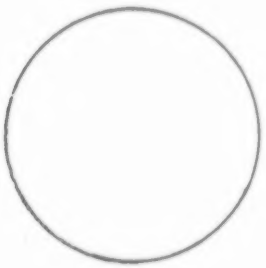
   d. Place a cover slip on the slide and observe under low power of the microscope.

      -- Why is it not possible to see any bacteria under low power?

      _____

      -- Carefully switch to high power. (Remember the precautions to be used when viewing under high power.)

   e. In the space below draw what you see under the microscope.



LABORATORY WORKSHEET 4.6 (continued)

NAME_____

f. Bacteria are classified by the shapes. Bacteria within these classifications are also known by the different groupings in which they are found.

SHAPE	ARRANGEMENT
round (coccus)	pairs (diplo)
rod (bacillus)	chains (strepto)
spiral (spirillum)	clusters (staphylo)

Try to identify and name any bacteria which you observe.

_____

_____

g. Do the bacteria move? _____

Describe this motion.

_____

_____

What do you think is responsible for this motion?

_____

_____

2. (If available) Observe the prepared slides of bacteria.

How do they differ from the slides of yogurt you observed?

_____

SUMMARY/HOMEWORK

1. What are the advantages and disadvantages of staining bacteria?

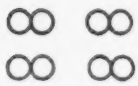
_____

_____

LABORATORY WORKSHEET 4.6 (continued)

NAME_____

2. Identify each of the following types of bacteria by its form and arrangement.



_____

_____

_____

_____

3. Why do you think it took so long to make a connection between bacteria and disease?

_____

_____

LABORATORY WORKSHEET 4.7

NAME_____ CLASS_____ DATE_____

PROBLEM: Where do we find bacteria in the school?

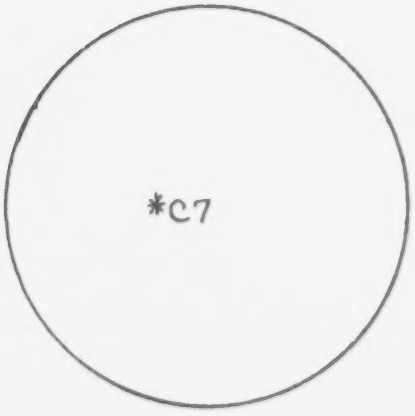
MATERIALS: Two sterilized petri dishes, marking pencil, sterile cotton swabs, scotch tape.

INTRODUCTION: Bacteria are everywhere. Unless you get an infection or grow them on a specially prepared medium, such as agar, you may not be aware of them. When grown on an agar plate they produce colonies. These eventually become large enough to be seen by the unaided eye. In this investigation you will be observing some of the growth forms of various bacteria.

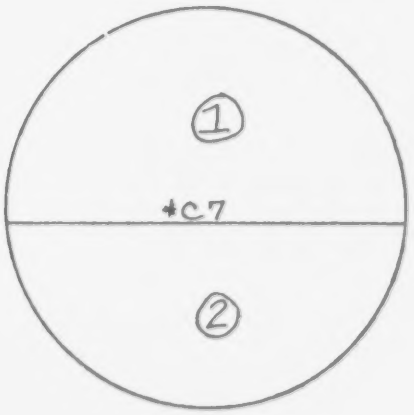
PROCEDURE

1. Carefully turn the two sterilized petri dishes bottom side up (so that the agar is facing you) on your laboratory table. DO NOT open the dishes.

2. Your teacher will give you a group code. Write your code in the center of each dish (see below). Divide one of the dishes, by drawing lines, into two halves. Number the top half "1" and the bottom half "2" so that it looks like the dish in Diagram B below.



A



B

Write your group code here _____

LABORATORY WORKSHEET 4.7 (continued)

NAME_____

3. Turn dish A right side up. Gently lift the cover and expose the dish to the air for about five minutes near an open window. Then replace the cover and seal the dish with tape.

4. Turn dish B right side up. Use a different cotton swab for each of the following procedures: [Note: Read both a and b before proceeding.]

   a. Rub a swab over your desk top. Then, gently roll the swab over Area 1 of the petri dish, being careful not to press the swab into the agar.

   b. Rub a swab over your hair. Then, gently roll this swab over Area 2, being careful not to press the swab into the agar. Seal your dish.

5. Throw all used swabs into the wastepaper basket.

6. Incubate petri dishes at 37°C for at least 24 hours.

SUMMARY/HOMEWORK

1. "Why must we wait at least 24 hours before using the petri dishes for observations?"

2. "Why do we have to keep the petri dish at 37°C?"

LABORATORY WORKSHEET 4.8

NAME_____ CLASS_____ DATE_____

PROBLEM: How can we control the growth of bacteria in our environment?

INTRODUCTION: Up until the mid-1800s, many surgical patients died, not of their original illness, but due to blood poisoning. Dr. Joseph Lister found that when antiseptics were used during operations, many more people lived. Today you will see why Dr. Lister was honored for his work in sterile surgery.

MATERIALS: Two petri dishes with colonies, dropper bottles of: common mouthwash (A_1), tinture of iodine (A_2), hydrogen peroxide (A_3), Lysol (B_1), adhesive tape, marking pencil.

PROCEDURE

1. Obtain the two petri dishes you used in Laboratory Worksheet 4.7. Using a sterile transfer loop, transfer bacteria to a fresh, sterile agar plate by streaking.

2. Soak discs of filter paper (approximately 2 cm in diameter) in solutions of antiseptics, disinfectants, and mouthwashes.

3. Using sterile forceps, place several prepared discs on a streaked portion of the petri dish. Use a glass marker to indicate on the bottom of the dish the contents of each disc.

4. Record the codes of the materials you added.

5. Tape your petri dish and return it to your teacher for incubation.

6. Copy the codes of the antiseptics and disinfectants you used:

_____ _____ _____

_____ _____ _____

7. Incubate plates for 24 hours. Examine, record and interpret results.

SUMMARY/HOMEWORK

1. Why would you expect the Lysol™ to be the most effective of all the materials added?

2. Why is the name "colonies" a good name for the growths in the petri dishes?

3. Why shouldn't you be surprised if some petri dishes contain no colonies?

LABORATORY WORKSHEET 4.9

NAME_____ CLASS_____ DATE_____

Bacteria reproduce by a process called fission, which means splitting. Complete the data table below. (You will need to know that it refers to a single bacterium which is undergoing fission into two parts every thirty minutes.) After you have completed the data table, plot the results on the graph below and connect all the dots with a single line.

THE GROWTH OF A BACTERIUM

NOTE: Some graph points may not fall on a line.

How many bacteria are there after

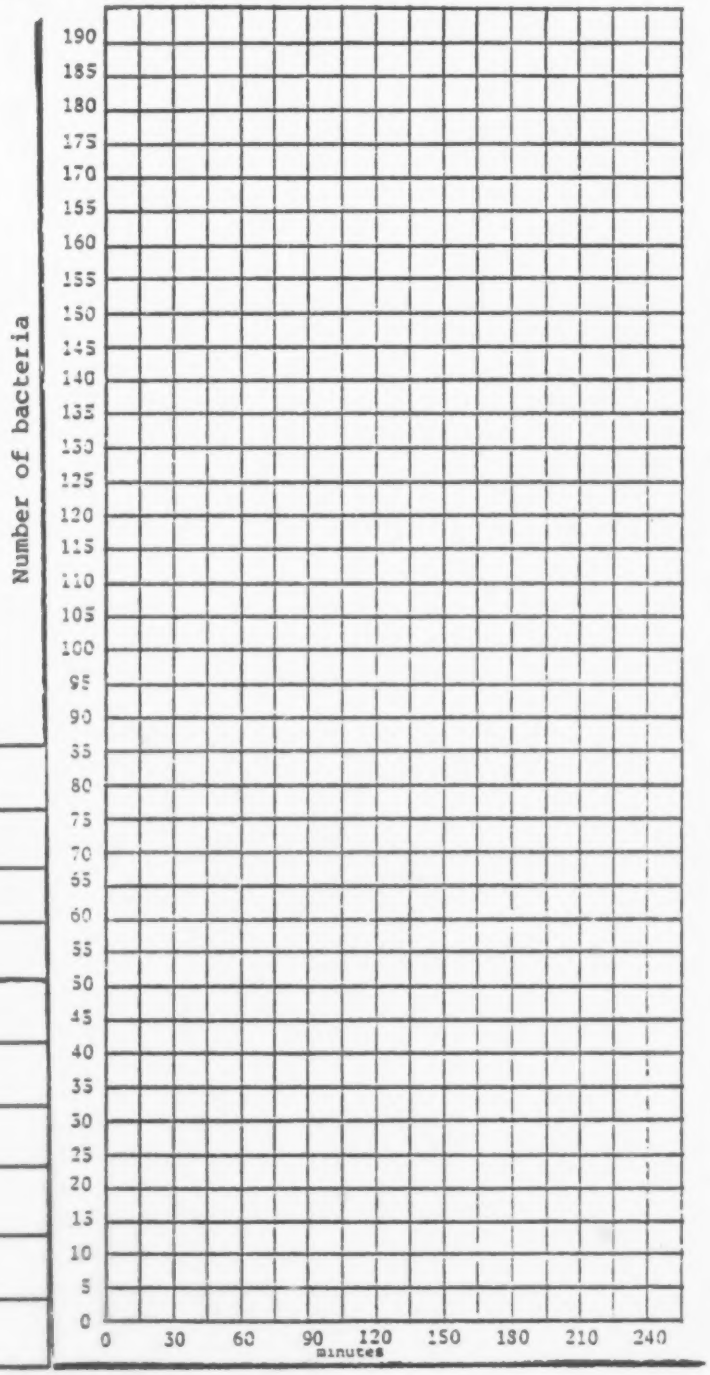
1 hour?_____

2 hours?_____

6 hours? _____

DATA TABLE

Time in minutes	Number of bacteria
0	1
30	2
60	
90	
120	
150	
180	
210	
240	



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